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ABSTRACT

This curriculum guide on housing and home furnishings, covering one of the five content areas of the Energy and the Family Curriculum Guide, has been designed to provide learning experiences and identify resources that can be used to develop units of study related to energy usage and conservation. The guide is intended for use in comprehensive courses of home economics as well as specialized courses of the home economics subject matter content areas, especially in the state of Texas. The guide contains three major units: selection of energy-efficient housing, evaluating a home for energy efficiency, and maintaining thermal comfort through interior design. Some of the subjects covered in the units are human needs and values; mobile homes, apartments, townhouses, and single-family dwellings; new types of housing, such as solar and earth homes; heat transfer and air infiltration; building an energy-efficient home; retrofitting existing homes; design elements inside and outside the home; and window treatments, furniture arrangement, and lighting. For each major concept, the guide provides a competency statement, terminal performance objectives, as well as concepts and generalizations linked to specific learning experiences and resources. The guide contains three appendixes. Appendix A contains a bibliography of books, pamphlets, multimedia materials, and other teaching aids. Appendix B contains prepared information sheets, games, bulletin board ideas, check sheets, evaluation forms, and transparency masters. Appendix C is a collection of background information that may be helpful to the teacher in using the learning experiences. A glossary completes the curriculum guide. (KC)

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FOREWORD

The level of energy literacy must be raised in our nation. The citizens of the future need to be more knowledgeable about energy and begin now to make wise decisions for the future use of energy. Home Economics Education programs are designed to teach decision making, value clarification, and identification of resources being used by individuals and families in the homes of our nation.

There are things we can do to help citizens of the future to be more knowledgeable about energy and begin to make wise decisions about use of energy. The Energy and the Family Curriculum Guide has been designed to provide learning experiences and identify resources that can be used to develop units of study related to energy usage and conservation. The guide has been prepared for use in comprehensive courses of Home Economics I and Home Economics, II, as well as specialized courses of the Home Economics subject matter content areas. Materials included in the guide are organized into five content areas of Home Economics:

1. Consumer Education
2. Foods and Nutrition
3. Home Management
4. Housing and Home Furnishings
5. Textiles and Clothing

Competency statements and terminal performance objectives were developed for the broad conceptual areas of study. Generalization statements related to key concepts were written opposite appropriate learning experiences. The domains and levels of learning were considered in developing learning experiences. Suggested resources were referred to and can be found in appendices at the end of each content area section. Appendix A contains a bibliography of books, pamphlets, multimedia materials and other teaching materials. Appendix B has prepared information sheets, games, bulletin board ideas, check sheets, evaluation forms and transparency masters. Appendix C is a collection of background information that may be helpful to the teacher in using the learning experiences.

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ENERGY AND THE FAMILY CURRICULUM

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SCOPE AND SEQUENCE CHART OF CONCEPTS RELATED TO
ENERGY AND THE FAMILY

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    3. Apartments
    4. Townhouses
    5. Single-family dwellings
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        a. Solar
        b. Earth
        c. Homes for the future

B. Evaluating a Home for Energy Efficiency
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    2. Air infiltration
    3. Building an energy-efficient home
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        b. house orientation
        c. glass area
        d. landscaping
        e. choice of heating and cooling alternatives
        f. kitchen planning
    4. Retrofitting Existing Homes
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            2. weatherstripping
            3. foam gaskets
            4. water heating conservation measures
            5. insulation
            6. shading devices
            7. storm or double-paned windows
            8. attic ventilation
        b. Home energy audit

C. Maintaining Thermal Comfort through Interior Design
    1. Design elements inside and outside the home
        a. color
        b. texture
        c. shape and form
    2. Window treatments
    3. Furniture arrangement
    4. Lighting
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        b. fixtures

FOODS AND NUTRITION

(Home Economics I)

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   1. Use and care of food preparation appliances and equipment
   2. Using cookware and bakeware
   3. Food cleanup techniques
      a. Hot water usage
      b. Handwashing vs. automatic dishwashing
      c. Disposal of waste

(Home Economics II)

A. Energy Conservation Practices in Use and Care of Food Preparation Appliances
   1. Conservation awareness
   2. Conventional ovens and surface units
   3. Microwave appliances
   4. Small appliances

B. Planning and Preparing Energy-Efficient Meals
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   3. Preparation during emergencies
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TEXTILES AND CLOTHING

(Home Economics I)

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      a. Color
      b. Texture
      c. Style
      d. Shape
      e. Accessories

B. Energy Management in Clothing Construction
   1. Management of energy in equipment use
   2. Construction projects
      a. Draft dodgers
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C. Personal Care and Energy Use
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A. Role of Clothing in Energy Management/Thermal Comfort
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      c. Climate
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E. Managing Leisure Time

F. Managing Existing Resources

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HOUSING & HOME FURNISHINGS

MAJOR CONCEPT: Selection of Energy-Efficient Housing - Human Needs and Wants

SUGGESTED FOR: Housing and Home Furnishings

COMPETENCY STATEMENT: Examine current values, attitudes and behaviors toward selection of energy-efficient housing.

TERMINAL PERFORMANCE OBJECTIVES: The student will be able to:

Question needs versus wants as related to energy used in the home.

Evaluate the type of housing needed for family lifestyles.

Differentiate between energy efficiency of various types of housing on today's market.

CONCEPTS AND GENERALIZATIONS	LEARNING EXPERIENCES AND RESOURCES
Human Needs and Values	
As the world's energy resources continue to be depleted, and energy costs increase, it has become necessary to evaluate our values, attitudes, and behavior related to energy.	*Have students make a collage illustrating their concept of an energy-efficient home. Complete Daily Activity Inventory See Appendix B, page 32.
Energy-efficient features in homes are becoming increasingly important to the consumer.	*View transparencies on Total Housing Cost Comparison for 1977, 1987, and 1997. Compare the increased cost of utilities of a home with standard construction to a home with energy-efficient construction in each of the years. Point out the savings gained. Compare principal and interest to utilities. See Appendix B, pages 33-35.
Popularity in types of housing is shifting due to energy costs.	
Homes are now being designed with less living area due to energy costs.	*Collect articles on current home energy features for bulletin boards "What's Happening." See Appendix B page 36. Have realtor or homebuilder speak on changing trends in the housing market based on family needs.

Types of Housing

The family's life cycle, needs, and values are considered in determining the most energy efficient type of housing.

Interview parents to find out what type of housing they have lived in since they were first married. Identify housing types for each stage of family life.

*Brainstorm the types of housing available today for people in different life cycle periods.

Construct bulletin board using pictures of family activities in various types of housing at different life cycle periods.

*Evaluate housing energy needs in different life cycle stages. Note activities requiring energy, effect of housing type on energy usage, etc. See Appendix B, pages 37-41.

Write a summary of the type of housing which would be most suitable for the student's family's needs, including the energy-efficiency features of each type.

Collect oral accounts regarding housing needs, using "Data Sheet." Interview families concerning their housing needs. Consider the following factors: number and ages of family members, daily family activities, and special hobbies. Determine the priorities listed by each family. Write a conclusion of these oral accounts.

Manufactured Housing

With the spiraling cost of home ownership, many American families are choosing less expensive types of housing such as the manufactured (mobile) home.

Manufactured housing is designed to be installed with or without a permanent foundation.

Many new mobile homes can be purchased with energy-efficient features.

Define manufactured housing.
Invite a GSU Marketing and Consumer Services person to present a program on Energy-Efficient Mobile Homes."

Visit a mobile home sales office to discuss and view energy-efficient qualities in manufactured homes.

Distribute handouts and compare specifications on a typical mobile home and one equipped with an "Energy Conservation Package." See Appendix B, 42.

Visit a mobile home plant to view energy-efficient construction features of mobile homes.

Existing mobile homes can be made energy-efficient.

*Show and discuss transparencies on energy-efficient features of new mobile homes and weatherization measures for existing mobile homes. See Appendix B, pages 43-47.

For detailed information, contact the Texas Manufactured Housing Association for booklet, "Manufactured Housing Makes Sense," Texas Energy and Natural Resource Advisory Council for booklet, "The Energy Efficient Manufactured Home in Texas," or Owens/Corning Fiberglas Corporation for booklet, "Mobile Home Reinsulation Package." See Appendix A.

Apartments

With the majority of apartment dwellers paying their own utilities in addition to rent, it is important that energy-efficiency be practiced to help keep costs down.

Because tenants do not have equity invested in the apartment building, the energy conservation measures should be low- or no-cost measures.

Visit a site with a builder where apartments are under construction and view energy-efficient construction methods.

Distribute copies of "Energy Savers for Apartment Dwellers" from Gulf States Utilities.

*Have students make a list of tips for conserving energy in apartments using the "Energy Savers for Apartment Dwellers." Discuss.

*Brainstorm the questions to ask while seeking an apartment in regard to energy efficiency.

Townhomes/Rowhouses

Because of high costs of owning and maintaining a home, more townhomes are being purchased.

In selection of a townhome, its energy-efficiency features should be considered.

Most of the energy-efficient features of a townhome are the same as for a single family dwelling.

*Brainstorm the advantages of townhomes vs. single family housing

Visit a townhome building site with a GSU N.E.W. energy auditor to view requirements for its certification as an N.E.W. (National Energy Watch) home.

*Obtain copies of pamphlet-"GSU Wants

Single-Family Dwelling

The single-family dwelling is the most popular type of housing; thus its selection must take into consideration its energy efficiency.

You to Know What's N.E.W." and discuss energy-efficiency standards.

*Have a GSU representative explain the N.E.W. (National Energy Watch) program for new homes - what to look for in selecting an energy efficient home.

Obtain copies of pamphlet - "Gulf States Utilities Wants You to Know What's N.E.W." (National Energy Watch) and discuss standards to be considered for N.E.W. certification.

Invite a building contractor to discuss energy-efficiency standards to consider when selecting a new home.

For Review

*Divide into groups to write and and present a commercial for selling an energy efficient home. Use acquired information. Divide housing types among groups.

Construct a bulletin board, "Let's Make An Energy-Efficient Deal." See Appendix B 48. Use pictures of types of housing available. List possible energy efficiency features available. Use play money to emphasize dollar savings.

MAJOR CONCEPT: Selection of Energy-Efficient Housing - New Types

SUGGESTED FOR: Housing and Home Furnishings

COMPETENCY STATEMENT: Evaluate energy efficiency in new types of housing

TERMINAL PERFORMANCE OBJECTIVE: The student will be able to:

Recognize alternative forms of energy-efficient homes.

CONCEPTS AND GENERALIZATIONS	LEARNING EXPERIENCES AND RESOURCES
Supplemental Forms of Energy for Homes	
The resources of sun, wind, and climate can be used to maintain comfort and convenience in the home.	*View film strip, "Solar Power, the Quest of Life" from "Energy Sources" multimedia kit available on loan from Gulf States Utilities Company.
Solar Homes	
Solar energy is a renewable form of energy.	*View and discuss transparency "How Renewable Energy Works." See Appendix B, page 49. Consult Homes With Character, Appendix A.
Solar energy may be used to supplement energy requirements of the home.	*View and discuss the transparency showing homes equipped with an active solar heating system and partially earth-sheltered, passive solar home. See Appendix B, page 50. See Appendix C, pages 161-162 for teacher reference.
Solar energy systems are categorized as being active or passive	Develop a bulletin board showing homes that are designed to use different forms of supplemental energy.
Site orientation is the key factor for a successful and cost effective solar system.	Visit a home with solar equipment and have the owner or builder explain the operation. Contact your local utility company to see if any solar building or research projects are being conducted in the area.
A properly oriented solar system can partially meet the energy needs of a home.	
Earth Homes	
Earth-sheltered housing is becoming acceptable to consumers	Visit an earth-sheltered home under construction, if possible.

because of low energy consumption, little upkeep and almost infinite life of underground buildings.

Well-designed passive homes incorporate energy-saving features beyond standard improvements such as insulation, weatherstripping, and caulking.

*Collect pictures and articles of earth-sheltered homes from magazines. Have students discuss pros and cons of earth homes in relation to climate and terrain.

Consult references such as "Passive Design: It's a Natural." See Appendix A.

*Develop a bulletin board 'Houses Underground (Dirt Cheap).' Include pros and cons to be considered if building a home underground. See See Appendix B, page 51.

Have a home builder or architect speak on building earth shelters.

Dramatize with role playing how you would describe your home to a classmate if it was the only underground home in the area.

Homes of the Future

Houses of the future will be designed for energy efficiency due to high costs and depletable resources.

Brainstorm ideas of what type homes might be available in the year 2000.

Refer to Chapter 34 "Looking Beyond 2000" in Teen Guide. Discuss types of homes found in "Road Map of the Future" found on page 254. See Appendix A.

*Divide into groups and create a commercial advertising the types of homes available in the year 2000.

Have students make a collage with pictures of new and future homes.

Construct a bulletin board on homes using supplemental forms of energy and homes of the future, such as solar, earth, etc.

MAJOR CONCEPT: Evaluating a Home for Energy Efficiency - Heat Transfer and Air Infiltration

SUGGESTED FOR: Housing and Home Furnishings

COMPETENCY STATEMENT: Recognize the different modes of heat transfer and uncontrolled movement of air within and around the home in relationship to energy efficiency.

TERMINAL PERFORMANCE OBJECTIVES: The student will be able to:

Identify the process of heat transfer in the home through conduction, convection, and radiation.

Define air infiltration as a form of heat loss.

Locate the primary areas of air infiltration in the home.

Determine how energy efficiency is reduced through heat transfer and air infiltration.

CONCEPTS AND GENERALIZATIONS	LEARNING EXPERIENCES AND RESOURCES
Heat Transfer Methods of Heat Transfer:	*Have students perform these simple experiments to help them understand the methods:
a. conduction: direct transfer of heat from one object to another	1. conduction: place hand on smooth surface for one minute. Now, touch the surface next to where you hand was.
b. convection: transfer of heat between objects via liquid or air medium	2. convection: blow on your dry finger held 8-10 inches from your mouth.
c. radiation: transfer of heat by electromagnetic radiation	3. radiation: hold the palm of your hand close to a lighted incandescent bulb. Can you feel the warmth? Now hold your palm close to the cheek of your face. The cheek feels warm and the palm becomes cool.
	Experiment with "curling fish" as a demonstration of heat transfer. See Appendix A to order.
Air Infiltration	
Air infiltration is the uncontrolled movement of air into or out of a home.	*View and discuss transparencies on on air infiltration. See Appendix B, page 52-54.

10 to 20 cents of every dollar spent for heating and cooling could be saved by minimizing air leakage.

*Construct a draft gauge to test for air infiltration at home. Test for leakage around windows and doors. See Appendix B, page 55.

Test for air leakage around windows and doors at school

MAJOR CONCEPT: Evaluating a Home for Energy Ffficiency - Building an Energy Efficient Home

SUGGESTED FOR: Housing and Home Furnishings

COMPETENCY STATEMENT: Evaluate a home for energy efficiency.

TERMINAL PERFORMANCE OBJECTIVES: The student will be able to:

Recognize the factors affecting energy efficiency of homes.

Make decisions that will affect energy efficiency of a home.

CONCEPTS AND GENERALIZATIONS	LEARNING EXPERIENCES AND RESOURCES
Shape and Surface Area	
Reducing the ratio of exterior wall to floor area will increase energy efficiency.	Discuss "Shape Planning Concepts" See Appendix B, pages 56-57. Analyze housing floor plans for energy-efficient shapes and surface area. Invite a professional architect or the drafting teacher to discuss the advantages and disadvantages of house shapes for energy conservation. Draw Various house shapes and explain their energy efficiency.
House Orientation	
When combining building strategies with specific outdoor designs, it is possible to attain natural comfort.	Read "Site Planning Guidelines for Energy Conservation" face sheet. See Appendix B, page 58. Read and discuss "Orientation" fact sheet. See Appendix B, page 59-60. View transparency "Control the Sun and the Wind" on methods of shading. See Appendix B, page 61. Determine the best orientation for floo plans on "House Orientation". See handout, Appendix B, page 62. Orient the floor plans of "House Orientation" handout. See Appendix B, page 63.

Study "Control the Sun and the Wind" pamphlet available from GSU.

Construct bulletin board "Use the Sun Wisely". Place tips for shading in summer and using sun in winter. See Appendix B, page 64.

Glass Area

Windows provide many positive functions such as satisfactory visibility of the outdoors and offer energy efficiency as well if designed properly.

*Brainstorm the functions of windows and why it is wise to have some windows in a typical home.

Windows are a major source of heat loss and gain in the home.

Discuss why windows are not energy efficient. See Appendix C, pages 169-17

There are several alternatives for minimizing heat loss or gain through glass area.

*Discuss methods for minimizing heat loss and gain using samples of solar film, solar screen, and a model or picture of a storm window. See See Appendix C, Pg. 171.

To minimize radiation, (heat gain) an outside shading device may be applied: 1. solar film, 2. screen 3. landscaping 4. awnings

To minimize heat loss, storm windows or double-paned glass may be added to windows.

In designing a home, the glass area should be 10% to no more than 20% of the floor area for minimizing heat loss & gain.

*Determine glass area in houses by viewing the "Window Area Worksheet Floorplans" on an opaque projector or overhead as class project. See Appendix B, Pages 65-76.

The glass area on the east & west should be no more than 4% of the floor area to minimize heat gain.

Students complete "Window Area Check Worksheets" for each floorplan. Report to class on findings. Discuss how the glass area can be made more energy efficient either by modifying the floor to the windows. See Retrofitting Existing Homes, Shading Devices and Storm or Double-Paned Windows for background information.

By designing most of the window area on the north and south, the sun can help heat the home during the winter.

*Use transparency to discuss glass areas for different exposures. See Appendix B, page 77.

Draw the glass area for the house to meet energy - efficiency standards. See Appendix B, page 78.

Landscaping

Proper landscaping with trees, shrubs, and ground cover play an important role in the overall energy efficiency of a home.

Visit a nursery to learn about using trees, shrubs and ground cover that can be effectively used in energy conservation.

Landscaping can reduce the hot sunlight hitting the walls, windows and roof, cut down on the wind velocity around the home, and modify the difference in outdoor vs. indoor temperature.

*View and discuss landscaping transparencies to determine principles of proper shading, insulating, and cooling. See Appendix B, pages 79-82.

Landscape a house by drawing trees and shrubs around the floor plan where needed. See Appendix B, page 83.

Evaluate your own home for landscaping designs or needs. Report to class.

Remedy a landscaping problem at home by planting a tree or shrub. Write a report on the project.

Heating and Cooling Alternatives

Since heating and cooling account for as much as 55% of the energy used in the home, it is wise to choose energy-efficient equipment.

*Discuss types of heating and cooling equipment used in this area. What types are used in other regions of the U.S.? See handout, Appendix B, page 84.

The central air system will be the most expensive appliance bought for the home; therefore, it is important to get the best equipment for the money.

*Discuss factors to consider in buying heating and cooling equipment as comparative shopping, E.E.R., or S.E.E.R., sizing of equipment, why it is important to use the ratio as a guideline for buying heating and cooling equipment? Contact your local utility company for rating recommendations. See Appendix B, pages 85-87 for handout on selecting energy-efficient equipment.

The E.E.R. or S.E.E.R. rating helps the consumer to determine and compare the operating costs of heating and cooling equipment.

The higher the rating, the more energy efficient the equipment.

Interview an air conditioning and refrigeration sales representative for information on equipment available on the market today.

Visit an "Energy Store" to see energy-efficient products related

to heating the home by fireplaces, or cooling by ceiling fans.

There are many ways to conserve energy used to heat and cool. The easiest and most effective measure is to raise the thermostat setting in the summer and lower it in the winter.

*Discuss types of fans and how fans can supplement air conditioning. See Appendix D, page 88 on ceiling fans.

Collect resources on heating and cooling alternatives. See Appendix A.

Talk to a home builder of energy-efficient homes on heating and cooling requirements in home building.

Ductwork (the room air delivery systems for central heating and cooling equipment) must be properly insulated and be free of leaks.

Discuss why ductwork should be energy efficient.

There are 4 factors that determine the energy it takes to heat and cool a home.

1. Changes in outdoor temperature and humidity.
2. Structural makeup of the home
3. Family size, structure and habits
4. Orientation of the home.

Kitchen Planning

To preserve human energy as well as time, a kitchen should be designed according to work simplification storage guidelines for efficient kitchen shapes.

*View filmstrip "Kitchen Planning Basics," Sears Consumer Information Services. See Appendix A.

Read and discuss "Kitchen Planning Basics," Hidden Values Booklets. See Appendix A.

Location of refrigerators and freezers away from sources of heat will increase their energy efficiency.

*Study Kitchen Planning Tips transparency. See Appendix B, pages 90-91.

Fluorescent lighting is an energy-efficient light source for kitchens, where optimum lighting is required.

Examine kitchen floor plans to determine energy efficiency.

Selection and use of energy-efficient as well as cost-efficient appliances (life cycle costs) is an important factor in kitchen planning.

Construct a bulletin board presentation of an energy-efficient kitchen. See "Kitchen Planning Tips," Appendix B, pages 90-91.

MAJOR CONCEPT: Evaluating a Home for Energy Efficiency - Retrofitting

SUGGESTED FOR: Housing and Home Furnishings

COMPETENCY STATEMENT: Select appropriate measures for making a home energy efficient.

TERMINAL PERFORMANCE OBJECTIVES: The student will be able to:

Identify heat loss or gain within an existing structure.

Identify areas of the home that can be made more energy efficient.

Identify use of various products used for retrofitting a home.

Demonstrate proper installation of weatherization products.

CONCEPTS AND GENERALIZATIONS	LEARNING EXPERIENCES AND RESOURCES
Retrofitting an Existing Home	
Energy requirements for an average home can be reduced up to 30% through retrofitting.	*Define the term "retrofit" and "payback." See Glossary.
The payback period, the amount of time it takes for an energy-saving improvement to pay for itself, should be considered when retrofitting.	Complete Crossword Puzzle on materials relating to energy efficiency. See Appendix B, pages 92-93.
	*Complete "What Is it? How Does It Relate to Energy Conservation?" Have the following items displayed for students to identify: 1. weatherstripping (spring metal) 2. piece of insulation 3. foam gasket for wall outlet 4. caulking 5. flow restrictors for shower heads/ faucets 6. weatherstripping (metal & rubber) 7. solar screen 8. solar film. Samples of various products used for retrofitting are available on loan from GSU in the "Energy and the Family Kit."
Inexpensive but effective retrofitting projects can involve caulking, weatherstripping, application of foam gaskets and of water heater	Invite GSU or local utility educational representative to speak on energy efficiency for an existing home by presenting the "Energy

jackets, shading the east and west glass and installing storm windows.

and the Family" slides.

Complete Word Jumble on Retrofitting. See Appendix B, page 94.

Caulking

Caulking is a flexible material used to fill up cracks where two immovable parts of the house meet to aid in stopping air infiltration.

*Define "caulking." Discuss why homes need to be caulked. See Appendix C, page 163.

View samples of caulking compounds and discuss properties of each of the different types as colors and durability. Samples from the Energy and the Family loan kit may be used. See Appendix C, page 163.

Care should be taken to select the most appropriate, durable type of caulking for the area of a home that needs to be caulked.

Show areas where a home should be caulked and how caulking is applied by viewing transparencies. See Appendix B, pages 95-96.

Weatherstripping

Weatherstripping is a material placed around doors and windows that keeps air in or out of a home.

*Define "weatherstripping."

*Discuss the types of weatherstripping, the general application, and the need of such products by viewing transparencies. See Appendix B, pages 97-98. See Appendix C, page 164.

Care should be taken to select the most appropriate and durable type for the area that needs to be weatherstripped.

View samples of weatherstripping and review durability and characteristics of types. Samples from the Energy and the Family Loan Kit may be used.

Weatherstripping must be applied accurately to stop air leaks.

Invite a building trades teacher or carpenter to demonstrate how to apply weatherstripping accurately.

Foam Gaskets

Foam gaskets are an inexpensive device for preventing air leakage through wall outlets and light switches.

*View and discuss transparency on "Addition of Gaskets to Wall Receptacles." See Appendix B, page 99. See Appendix C, page 164.

Demonstrate in classroom how to apply a gasket to wall outlet. Students will either apply caulking & weatherstripping to some area of

the school or at their own home using the information on pages 95-99 in Appendix B. FHA members may choose to do this to an elderly person's home to help them save on utilities.

Water Heating Conservation Measures

Next to heating and cooling, water heating is the next largest part of the utility bill.

*View and discuss transparencies on on insulating a hot water heater. See appendix B, pages 100-101.

Water heater jackets are relatively inexpensive and very effective in cutting water heating costs.

Fit a jacket onto the Home Economics Department water heaters.

A water heater jacket is additional insulation added to the outside of the water heater to keep the heat from escaping from the water tank.

Check water heater in Home Economics Department for heat loss. Note temperature. (Schools may have different temperature requirements than a home).

For energy efficiency, the temperature of a home water heater should be 120° to 140°F. 130° to 140°F is needed for a dishwasher.

*Check the hot water tap temperature by using a thermometer and a glass filled with water drawn from pipes closest to hot water heater. (Use a cooking thermometer).

A flow restrictor can reduce the flow of water in showers and faucets from about 10 gallons to 2-3 gallons per minute.

View and discuss transparencies on other water heating conservation measures such as insulating pipes, repairing leaky faucets and installing flow restrictors. See Appendix B, pages 102-103. See Appendix C, pages 165-166 for detailed instructions.

A leaky water faucet should be repaired because on drop a second can waste as much as 60 gallons a week.

If hot water pipes are located in an unheated area, they can be insulated to reduce heat loss from the tank to the faucet.

Demonstrate how to wrap pipes using the two types of insulation.

Most people require less water for showering than bathing.

*Students will do the activity "Shower vs. Bath" to determine which uses less water. See Appendix B, page 104.

The major uses of hot water in the home are for bathing and laundry.

Complete the "Hot Water Audit" Activity to determine the weekly consumption of hot water in students' homes. See Appendix B, pages 105-106.

Insulation

Insulation is a material used in a home to retard heat loss in the winter and heat gain in the summer.

If a home has no or very little insulation, then much heat will be lost from the home during the winter and much heat will move into the home during the summer.

R-value is the measure of insulating material's resistance to heat flow or transfer.

The greater the "R" number, the greater the insulating value.

*Define "insulation", "R-value", and "vapor barrier". See Glossary.

*View and discuss insulation transparencies on types of insulation, where to insulate and R-values. See Appendix B, pages 107-109. See Appendix C, pages 167-168.

View samples of insulation from the Energy and the Family loan kit.

Test insulation value of various materials by experimenting with ice. See Appendix B, page 110 for experiment, "Make a Container That Will Keep an Ice Cube from Melting."

*Determine the best insulating and noninsulating material. See Appendix B, pages 111-112 for experiment, "What's the Best Insulator?" and "The Great Hot Tea Race."

Complete "House Insulating Activity" to determine where to insulate and the best suited type. See Appendix B, Pages 113-115. See Appendix C, page 168 for answer.

Shading Devices

Outdoor shading devices can block out approximately 75% of direct solar radiation.

An outdoor shading device is seven times more effective than an indoor shading device in stopping solar radiation from entering the home.

The sun's rays are stronger and more direct on the east west sides of the home for a longer period of time in the summer.

*Discuss why it is necessary to shade east/west glass. Discuss why it is notnecessary to shade north or south facing glass. See Appendix C, page 170.

Brainstorm about shading devices for east and west glass. See Appendix C, page 170-171.

Collect pictures from magazines on shading devices such as awnings, trees, outdoor shades, solar screen, solar solar film, outdoor shutters.

View samples of solar film and solar screen from the Energy and the Family loan kit.

Unshaded east and west glass results in increased cooling requirements and higher utility bills.

*Conduct classroom experiment on how solar film and solar screen reduces radiation. See Appendix B, page 116.

Demonstrate the application of solar film.

Storm or Double-Paned Windows

A home loses about 30% of its heat through windows. Glass by itself offers almost no resistance to the passage of heat; therefore, ten to twenty times more heat escapes through a square foot of window than through a square foot of insulated wall.

*Discuss why glass area is not energy efficient, but why it is needed. See Appendix C, page 169.

Discuss types of windows and ways to increase R-value of windows. See Appendix C, pages 169-170.

A storm or double-paned window increases R-value, minimizing heat loss.

Using transparencies, discuss how storm and double-paned windows minimize heat loss. See Appendix B, pages 117-118.

A storm window is a pane of glass or other transparent material placed on the inside or outside which creates a dead air space between it and the original window, reducing heat flow. Double-paned glass is two panes of glass with a dead air space in between.

*Research ways to make inexpensive plastic storm windows. Include costs. Order booklet on low cost storm window from GSU Consumer Services Department.

Ask a utility representative or a government agency representative to demonstrate how to make a plastic storm window.

As an FHA project, construct storm windows for a needy home in the community.

As a home experience, construct storm windows for an individual home.

Survey your neighborhood for energy-efficient window modifications.

Attic Ventilation

Attic ventilation is needed to remove heat and moisture from the attic.

*Discuss why attic ventilation is needed. See Appendix C, pages 172-173.

Without attic ventilation, heat buildup may become excessive and continue to radiate into the rooms or space below, increasing cooling requirements.

View transparencies on how ventilation is accomplished and types of attic ventilation. See Appendix B, page 119.

Moisture buildup in the attic may cause deterioration of lumber and equipment, and decrease R-value of insulation.

Home Energy Audit

A home energy audit can be used to determine energy efficiency of the home.

Complete the activity "Decisions to Weatherize." See Appendix B, pages 120.

Complete Energy Checklist or Home Energy Check on individual home. See Appendix B, pages 121-130.

As a home experience, plan and carry out a retrofitting project at home. Complete an energy audit, etc.

Prepare a presentation on findings and feelings about weatherizing or retrofitting and conservation practices.

Conduct a publicity campaign to create public awareness of the energy situation.

MAJOR CONCEPT: Maintaining Thermal Comfort Through Interior Design - Design Elements

SUGGESTED FOR: Housing and Home Furnishings

COMPETENCY STATEMENT: Show awareness of the design elements that create energy efficiency and aesthetic decor in the home.

TERMINAL PERFORMANCE OBJECTIVES: The student will be able to:

Discriminate the psychological effect of cool colors vs. warm colors.

Recognize the use of texture as an energy-saving decorating factor.

Relate shapes and forms of home furnishings to energy efficiency.

Analyze quality of exterior finishes of the home for energy efficiency.

Explain reasons for furniture arrangement that contribute to energy efficiency.

Choose appropriate window treatments for energy efficiency.

Select energy-efficient lighting according to use.

CONCEPTS AND GENERALIZATIONS	LEARNING EXPERIENCES AND RESOURCES
Design Elements Inside and Outside the Home	
Color	
Color usage has a strong psychological effect on people.	*Construct a color wheel dividing the cool colors and warm colors. See Appendix B, page #131.
Light colors reflect heat and dark colors absorb heat, and both can affect the amount of heat and air conditioning the house will use.	*Cut out and discuss magazine pictures of rooms. Mount on construction paper and identify the psychological effect of each room (display on bulletin board). Experiment with which color holds heat the longest in juice cans. See Appendix B, page 132. Color one sketch to create a feeling of warmth and another a feeling of of coolness. See Appendix B, pages 133-134.

Texture

The addition of texture creates a feeling of warmtn, whereas smooth surfaces create a cooler atmosphere.

Brainstorm the different textures in the home. Analyze the psychological feeling each surface achieves.

*Compile samples of fabric swatches, floor coverings, and wall coverings that indicate cool and warm feelings. See Appendix B, pages 135-136.

Shape/Form

A sparsely decorated room creates a feeling of coolness in contrast to a room filled with cozy warm furnishings.

*View and discuss transparencies on "Energy Efficient Decorating." See Appendix B, pages 137-140.

Draw or write in furnishings, etc. that demonstrate energy-saving decorating for warm weather and cold weather. See Appendix B, page 141.

View videotape "Energy-Efficient Floor Coverings, Furniture and Furniture Placement, As Use of Design Elements." See Appendix A.

Design Elements Outside the Home

The right choice of exterior finishes result in beauty and efficiency of the home.

The color of the roof and walls of a house can be very important in determining the amount of heat and air conditioning the house will use.

Interview a home builder for exterior materials used in home building that relate to energy savings.

Collect samples of roofing materials for analysis of energy efficiency.

Develop a bulletin board on color and conservation. See Appendix B, page 142.

Color the exterior finish of a house to achieve the best possible energy efficiency. See Appendix B, page #143.

Energy-Efficient Window Treatment

Windows are a major source of heat loss in the home. Ten to twenty times more heat escape through a square foot of window than through a square foot of wall.

*View "Energy Efficient Window Treatments" slide presentation presented by GSU educational representative.

Discuss types of window treatments that insulate. See "Energy-Saving Window Treatments." See Appendix

An effective insulating window treatment will add a higher insulating or R-value to the window.

An energy-efficient window treatment must either trap air between itself and the window or stop direct heat gain from the sun. Some window treatments do both.

Indoor window treatments may also shade or block radiation but outdoor treatments are seven times more effective.

B, pages 144-145.

Examine the anatomy of a window insulator. See Appendix B, page 146.

Analyze R-values for various types of window treatments. See chart, Appendix B, page 147.

Catalog shop for good window insulators.

Introduce window insulator project ideas. See Appendix B, pages 148-149.

*Design and construct a window treatment that is decorative and energy-saving for the home.

Furniture Arrangement

Placing furniture to permit easy circulation of heated or cooled air is an inexpensive way of getting the most out of the energy dollar.

Discuss "Do's and Don'ts of Furniture Arrangement," and draw furniture pieces on a floor plan to illustrate energy-saving arrangement. See Appendix B, page 150.

*Analyze pictures of furnished rooms to determine best energy-efficient placement.

Lighting

Lighting and small appliances account for approximately 10-14 percent of the electricity used by a typical home.

*Brainstorm to identify lighting uses in the home. Compare cost of using candles vs. electric.

Collect resource pamphlets on lighting to understand lighting use and availability.

There are 3 general types of lighting needs:
1. General lighting
2. Task lighting
3. Special purpose lighting

Use proper lighting for the assignment - it saves energy.

*Discuss lighting basics and terminology. See Appendix B, page 151.

Bulbs

Significant savings can be achieved by using various

*View slide presentation from GSU on energy-efficient lighting.

new types of energy-efficient lighting in place of incandescent lighting.	
Approximately 90% of the electrical energy that enters an incandescent light bulb becomes heat added directly to the living space.	*Discuss types of bulbs. See Appendix B, pages 152-154. Demonstrate relative energy efficiency of fluorescent and incandescent lighting. See Appendix B, page 155.
Fluorescent bulbs supply approximately four times as much light, last approximately seven times longer than incandescent bulbs, and is a cool form of lighting.	Examine packages of fluorescent and incandescent bulbs to compare energy efficiency (lumens per watt).
Reflector bulbs, which supply twice as much light and last two to two and one-half times longer than incandescents, are an energy efficient alternative for "down lighting."	Study types of fluorescent, reflector, and 3-way bulbs, by viewing display. Brainstorm possibilities of areas where these could be used. Evaluate the lighting used in individual homes. List ways of improving efficiency. Brainstorm about the energy-efficient use of lighting. Construct bulletin board, "Wasting Energy is A Turn Off." See Appendix B, page 156.
Practicing energy saving lighting tips can reduce energy consumption.	*Discuss "Electricity Saving Home Lighting Tips" to determine saving opportunities. See Appendix B, pages 157-159.
<u>Fixtures</u>	
Fixtures recessed (penetrating) into the ceiling allow air leakage and, therefore, waste energy.	Visit a light fixture store and discuss with a sales person the lighting products available.
Surface-mounted fixtures or structures are more energy efficient. Selecting the right size and shape of shade, the right bulb, and the right location allows accurate and easy visibility with minimum use of energy.	*Survey various lighting structural designs and fixtures within the home. Evaluate in terms of energy efficiency. Note recessed spotlights and recessed fluorescent fixtures. Discuss why surface mounted fixtures or structures are more energy efficient. Plan lighting needs for the home.

Use "The Light Book" from G.E. as a guide for placement and types of bulbs and fixtures.

APPENDIX A

HOUSING AND HOME FURNISHINGS

Appendix A - Bibliography
Housing & Home Furnishings

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APPENDIX B

TEACHING MATERIALS

HOUSING AND HOME FURNISHINGS

DAILY ACTIVITY INVENTORY

I. Record your daily activities that take place in the home which cause energy to be consumed.

Examples of Activities

1. How many baths or showers do you take? Do you use hot water or cold water and how long do you shower?

2. What temperature do you set your thermostat on for heating and cooling? How long do you leave it on this temperature?

3. Are ceiling fans or portable fans used?

4. Do you watch television and how long?

5. What personal grooming appliances do you use - blow dryer, electric razor, etc...?

6. Do you cook?

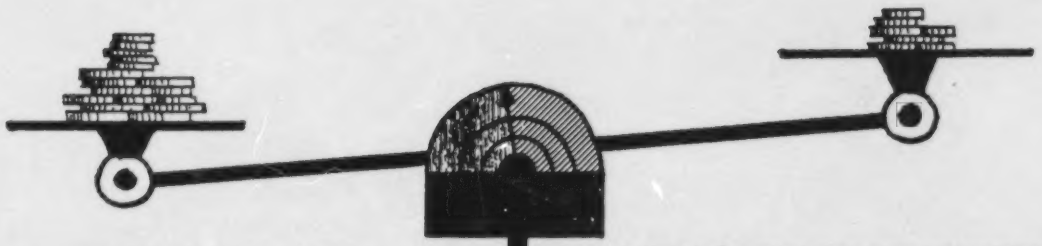
7. What laundering tasks do you do - washing and drying (how many loads, are they full loads, and what temperature is your wash water)?

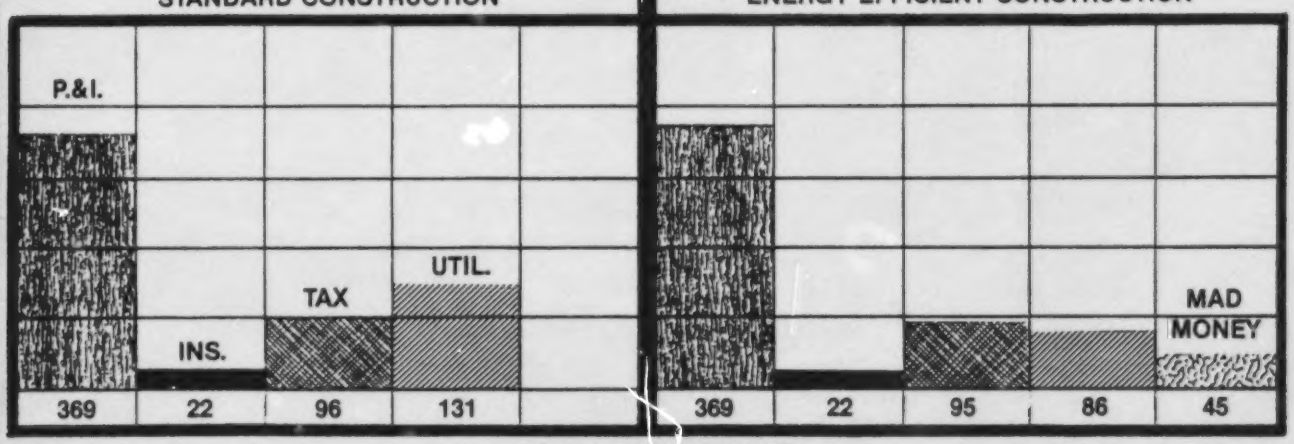
8. What outside activities do you do - mow the grass, cookout, swim, etc...?

II. From your list of activities, check the ones that require the use of energy.

III. Examine your activities that require the use of energy; in what ways could you perform these activities using less or no energy?

Total Housing Cost Comparison





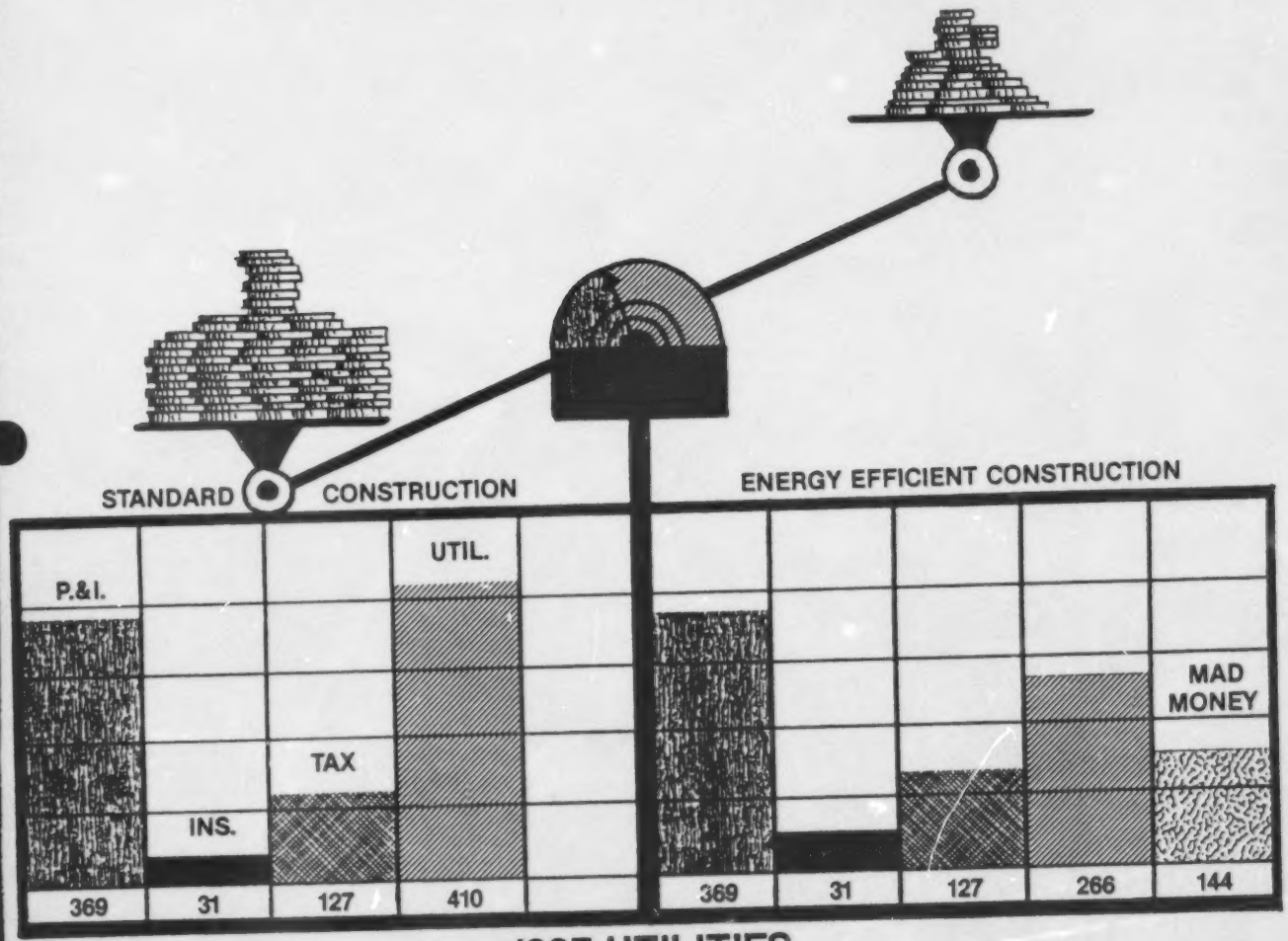
1977 UTILITIES

Total Housing Cost Comparison

STANDARD CONSTRUCTION					ENERGY EFFICIENT CONSTRUCTION				
P.&I.									
			UTIL.						
		TAX							MAD MONEY
	INS.								
369	26	110	231		369	26	110	131	80

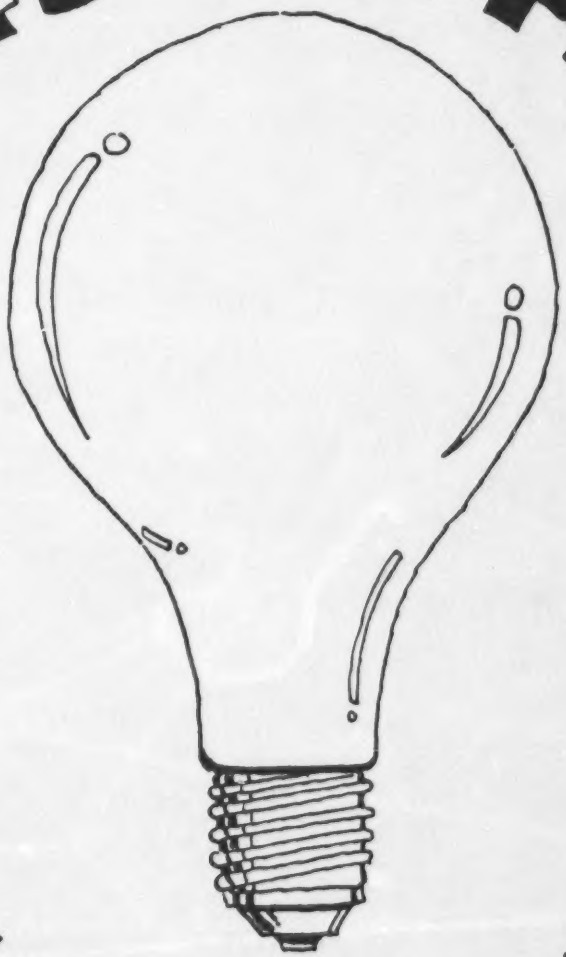
1987 UTILITIES

Total Housing Cost Comparison



1997 UTILITIES

WHAT'S HAPPENING IN THE HOME?



HOUSING NEEDS IN DIFFERENT LIFE CYCLE PERIODS

Evaluate housing energy needs in each family description below. Identify the type of housing the family might choose and why. What are the possible activities requiring energy usage that each family would be involved in? How would the housing type selected affect energy usage? Give a possible solution for making the house or dwelling energy efficient or for guidelines in shopping for a new home or dwelling. Give solutions for activities affecting energy usage, if possible.

I. A family of five, including three children ages 15, 12, and 8. The father works at the refinery. The mother sells cosmetics in the neighborhood.

1. Housing choice:_____ Why? _____

_____

2. Activities affecting energy usage:_____

_____

_____

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_____

3. Effect of housing type on energy usage:_____

_____

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4. Possible solutions:_____

_____

_____

II. An elderly couple that has retired from teaching. Both enjoy indoor hobbies and traveling.

1. Housing choice:_____ Why?_____

_____

2. Activities affecting energy usage:_____

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3. Effect of housing type on energy usage:_____

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4. Possible solutions:_____

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III. A young couple plus their three month old baby. Both parents have jobs outside the home.

1. Housing choice:_____ Why?_____

_____

2. Activities affecting energy usage:_____

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3. Effect of housing on energy usage _____

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4. Possible solutions:_____

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KEY

The following are suggested answers:

I. Family of five

1. Single family dwelling. Why? Larger amount of living space required as compared to a couple without children; a yard is desired.

2. Children are probably very active in school and club activities which results in a high energy consumption (from opening & closing doors, large amount of laundry from being in various activities, using hot water in bathing and grooming). Transportation costs probably high due to taking children to and from school and club activities.

3. Single family dwelling may not be very energy efficient. Family could request an energy audit to find out how and where the home is wasting energy. The family could then have a group project to weatherize the home together. Low- and no-cost projects could be done, such as weatherstripping and caulking. The family members should also take inventory of their energy habits. (List ways in which energy habits could be modified.)

II. Retired couple

1. Apartment, townhouse, or mobile home. Why? Couple desires less living area and desires home with little maintenance and time required for upkeep.

2. Activities requiring energy usage are probably minimum. Older couples are usually more conservative; however, older people are usually more cold natured, which would require more energy to heat home during cold weather. Sometimes the elderly require more energy use such as air conditioning for health problems due to a heart condition or emphysema, etc.

3. Energy use could be higher than necessary unless types of housing are certified as being energy efficient. Couple should shop carefully and compare features. Before buying a home, the couple should find out what needs to be done to the home and estimate expenses to make it energy efficient. Couple should inventory energy habits to determine if they can be more conservative.

III. Young couple

1. Mobile home. Why? Practical investment in regard to income, mobility.

2. Energy use could be very high at this life cycle stage because of more laundering, being up more at night with an infant;

heating/cooling use might be higher due to temperature settings required for the infant.

3. Mobile homes may not be very energy efficient, unless manufactured with energy-efficient features; older mobile homes would probably not be energy efficient unless previous owners weatherized them. Couple should shop carefully for an energy-efficient mobile home; if buying an existing mobile home, couple should find out what needs to be done to make it energy efficient and consider expense involved. Energy usage regarding habits are probably difficult to change at this time due to infant's requirements.

TYPICAL MOBILE HOME SPECIFICATIONS

SIZE:	65' x 14'; 910 square feet
GLASS:	95 square feet of single-paned windows;
	86 square feet of glass subject to solar heat gain
CEILING:	910 square feet; R-14 insulation*
WALLS:	1,417 square feet; R-7 insulation
FLOOR:	910 square feet; R-7 insulation

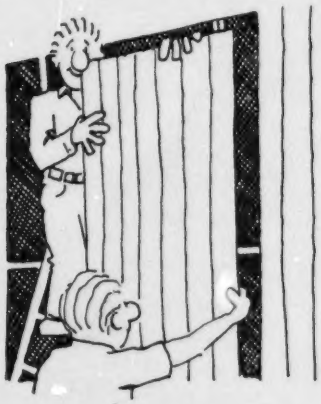
TYPICAL MOBILE HOME SPECIFICATIONS
EQUIPPED WITH ENERGY CONSERVATION PACKAGE

SIZE:	65' x 14'; 910 square feet
GLASS:	95 square feet of double-paned windows;
	86 square feet of shaded glass not subject to solar heat gain
CEILING:	910 square feet; R-26 insulation
WALLS:	1,417 square feet; R-13 insulation
FLOOR:	910 square feet; R-13 insulation

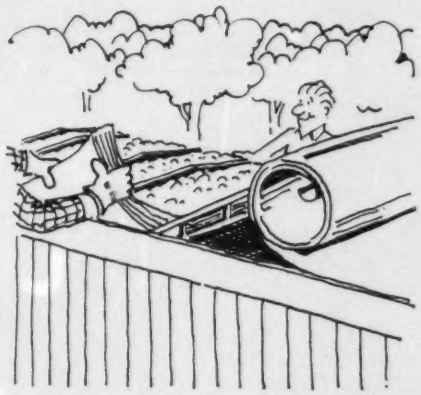
* Mobile homes built before 1976 may have less than an R-14 ceiling insulation.

INSULATING AN EXISTING MOBILE HOME

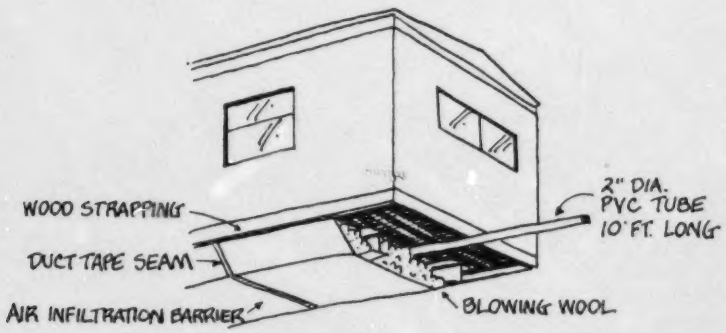
As with double-paned windows, additional thermal insulation in the ceiling, exterior walls and under the floor can make your mobile home easier to cool and heat. This means that the air inside your mobile home that you have paid to cool in the summer and heat in the winter will stay right there -- inside your home. The R-values shown above indicate the resistance to heat transfer, not necessarily the thickness of the insulation. The thickness, measured in inches, will be different for different types of insulation. Always check the R-value, not just the thickness.



The walls of an existing mobile home may be insulated by removing windows, doors, and siding.



The roof of an existing mobile home may be reinsulated by propping up the roof and blowing in insulation or by rolling back the roof and laying in batts of insulation.



The floor area of an existing mobile home may be insulated by removing the skirting and securing loose insulation with an air infiltration barrier.

ORIENTATION AND SHADING

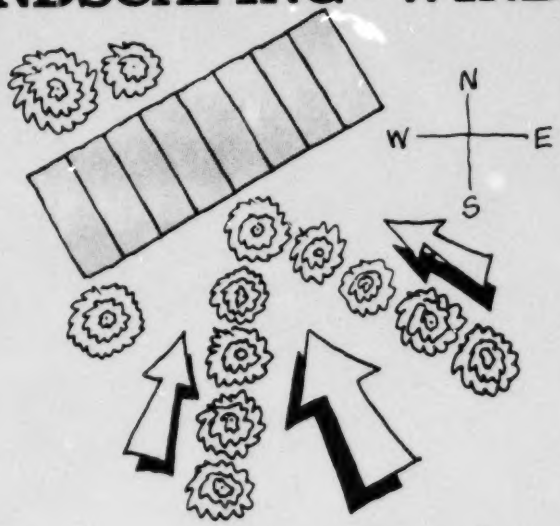
The best way to position a mobile home is to face the long sides toward the north and south. This eliminates most of the windows facing the east and west sun. The sun's heat coming in through the windows will cause the air conditioner to run much longer than necessary in the summer. This extra operation of equipment will use more energy and cost more money.

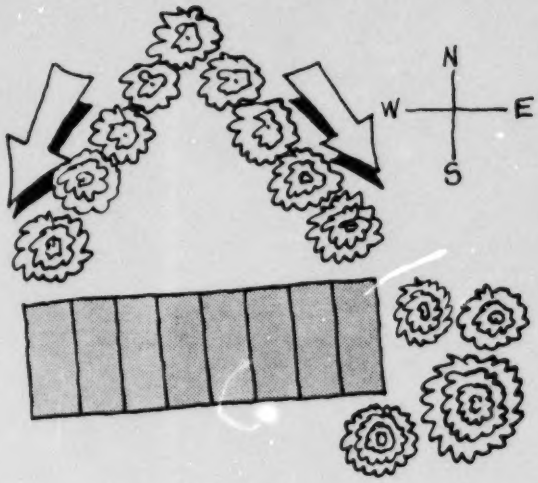
If you cannot orient your mobile home properly, you should seriously consider installing awnings or another means of exterior shading for all windows on the east and west sides. This exterior shading will prevent the sun's heat from getting inside your mobile home through the windows. A variety of awnings can be mounted over your windows to provide shade. To prevent heat buildup, the awnings should be ventilated at the top. Louvered sunscreens are also available. These screens, composed of rows of tiny, angled slats, block the sun's rays in the summer, when the sun is high in the sky, and allow the sunlight to enter in the winter, when the sun is low in the sky and heat gain is desirable. Fiberglass solar screens or reflective films can also be used on east- and west-facing windows.

Roller blinds and shutters block the sun completely and provide an insulating layer of still air against the external surface of window pane. Thus, blinds and shutters can both prevent heat gain in the summer and reduce heat loss on cold winter nights.

The most attractive of all external heat gain retardants are trees which lose their leaves in winter. In summer, when they are in full leaf, they shade your windows and walls. In winter, when they lose their leaves, the sunlight can stream through and help heat your home.

LANDSCAPING - WINDBREAKS AND FUNNELS





In hot arid regions, orient the house 25° south-southeast and consider the use of landscaping such as evergreen trees that will channel air towards your home and also provide year around shading.

In hot humid regions (such as along the Gulf Coast) orient your home 5° south-southeast and consider a landscaping windbreak to cut cold northern winds.

Landscaping can make a big difference in your home's energy consumption. Landscaping also can be expensive, especially when it involves planting large numbers of trees. Windbreaks and wind funnels can make a big difference in the comfort and energy efficiency of your home, depending on the climate and wind conditions.

Caulking and Weatherstripping : Controlling Air Infiltration. If you were to add up all the cracks around windows and doors in your manufactured home, the gaps where plumbing and electrical wires pass through the walls, the spaces between doors and thresholds and other openings, the combined area could easily be as large an an open window. Air infiltration, the uncontrolled movement of air through these openings, is a particularly important problem in manufactured housing. The sealing of joints and seams can be damaged during transit, and windows and doors can be forced out of alignment. In addition, many older manufactured homes (those built before the 1976 HUD standards went into effect) were built in the days when it was cheaper to heat and cool than it was to caulk and weatherstrip. Homes built in compliance with the HUD standard probably are sufficiently weatherized, especially if built to Zone II (northern) standards.

Skirting. If your manufactured home is located in a park, skirting may be required by park rules. Skirting makes the homes look more attractive. Regardless or where you manufactured home is located, however, skirting is most important for other reasons - it cuts draftiness through the bottom of your home, helps insulate your floor, and reduces the likelihood of frozen water lines.

Storm Windows. Double-paned windows, or storm windows, with their insulating "dead' air space, are more resistant to heat transfer than are single-paned windows. This heat transfer occurs because heat moves from a warmer area to a cooler area.

In the summer, the high temperature of the outside air can be transferred into your mobile home through the single-paned glass of ordinary windows, causing your air conditioner to run longer and costing you more money. In the winter, the heat inside your home can also be lost to the colder outside air, causing your heating system to run longer.

Double-paned windows, or storm windows, can reduce this heat transfer significantly, compared to single-paned windows. Today's typical mobile home has an average of eight windows.

Water Heater Insulation. Even though today's water heaters have some insulation installed between the water tank and the outer shell, additional savings are possible by adding a water heater insulation wrap. Since the water heater in your mobile home is probably located outside the living area (it's in that small compartment with the outside door), that means it's also losing heat to the outdoors.

By adding an extra layer of R-2 insulation, you will be helping to hold the heat in the water tank longer. That means your water heater won't come on as often. And that means you'll be saving money. This one item has the quickest payback of all the items in the energy conservation package.

Cooling and Heating Systems. SEER stands for Seasonal Energy Efficiency Ratio and it tells you how many BTU's (British Thermal Units) of cooling you get

for every watt of electricity used to run your air conditioner. The higher the SEER, the more energy you save. As a result, your monthly operating cost will be lower. On the other hand, the lower the SEER, the more it will cost to run your air conditioner.

We recommend an SEER of 9 or more for central air conditioning systems, and 8 or more for window units. (Window units are measured by EER rather than SEER). It's true that a lower EER air conditioner costs less to buy, but it will cost more to run than the same size unit with a higher EER.

Actual savings depend on many factors such as the construction of your mobile home, its orientation on your lot, the amount of insulation, your thermostat setting, your lifestyle and your energy conservation habits. But an air conditioner with an SEER of 9 will save you about $200 (or about 30%*) on your annual cooling costs, as compared to one with an SEER of 6.

While you are shopping for your cooling and heating system, ask your mobile home dealer or utility company about the use of a heat pump to provide efficient year-round cooling and heating. They can help you consider all the options, and you can decide on the most economical way to cool and heat your new mobile home -- both today and in the years to come.

*Based on a 3 ton cooling system operating for 2,000 hours per year at a thermostat setting of 75°F.

LET'S MAKE AN ENERGY-EFFICIENT DEAL

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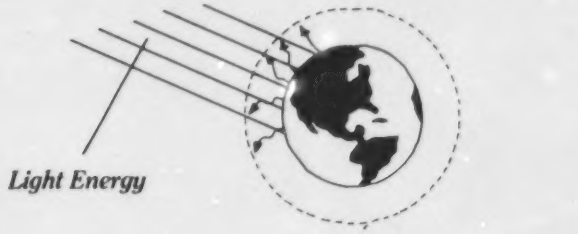
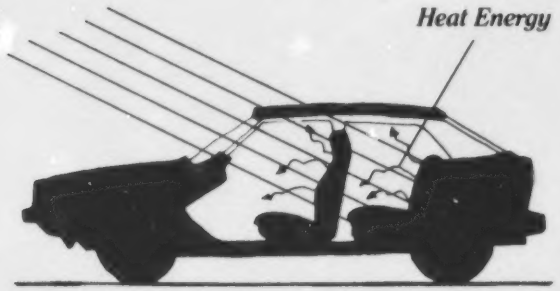
How Renewable Energy Works

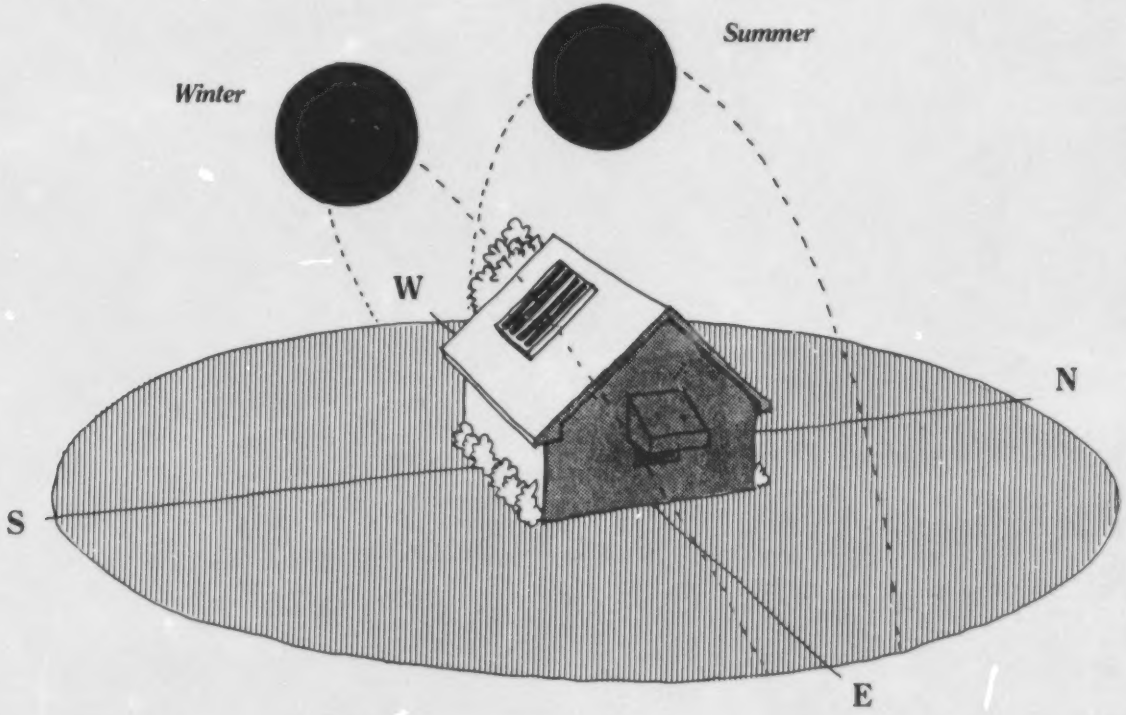
The atmosphere of the earth traps heat energy from the sun, just as a car heats up when the windows are closed. This is sometimes called the "greenhouse effect."

Modern solar energy systems are designed to duplicate and control this natural process in an efficient and economical way. Energy from the sun is first captured by some type of collector. If that energy is not used immediately, it is sent to a storage system for use when the sun is not shining. This stored energy is then distributed when it is needed. Most systems rely on a back-up energy system to take over when there isn't enough renewable energy held in storage. Automatic or manual controls regulate the operation of the entire system.

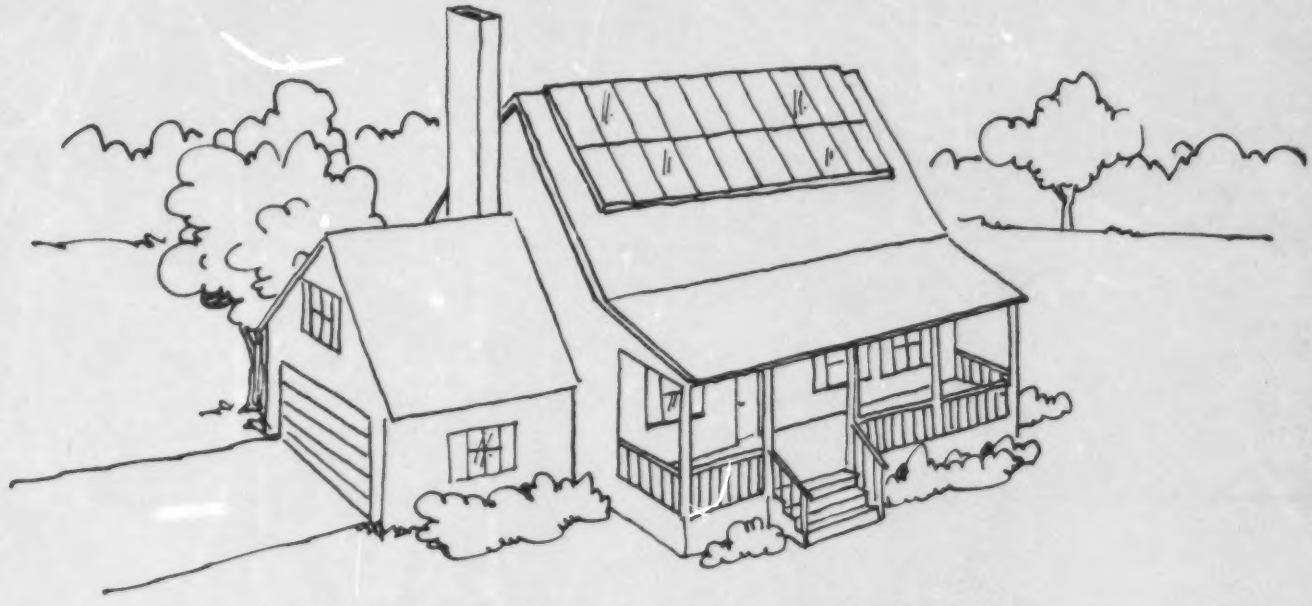
Solar energy systems, to be most effective, should be designed for maximum orientation to the sun. The position of the sun in the sky is lowest during the winter, and highest during the summer. This underlying principle affects the application of all the solar energy systems discussed in this booklet.





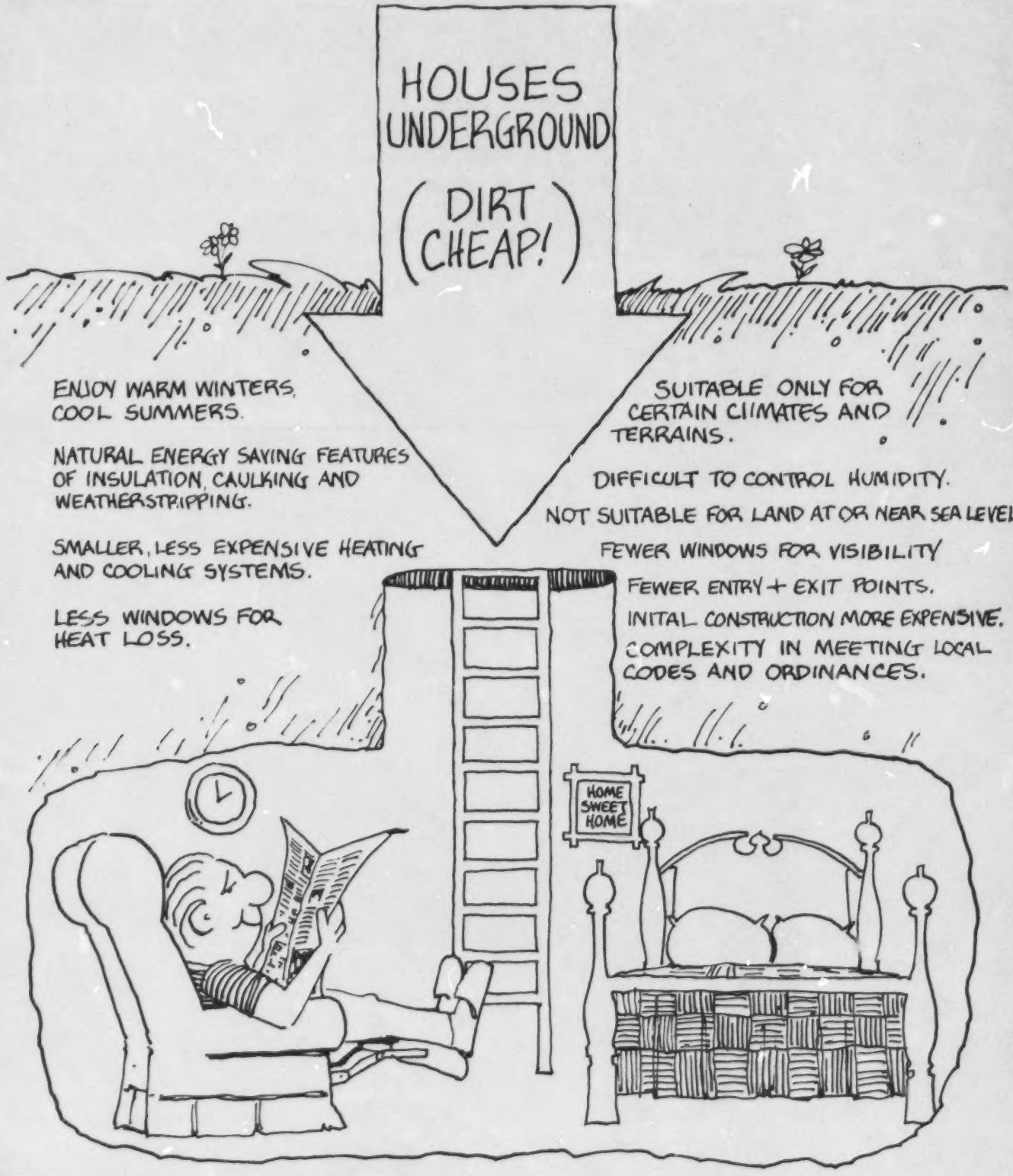


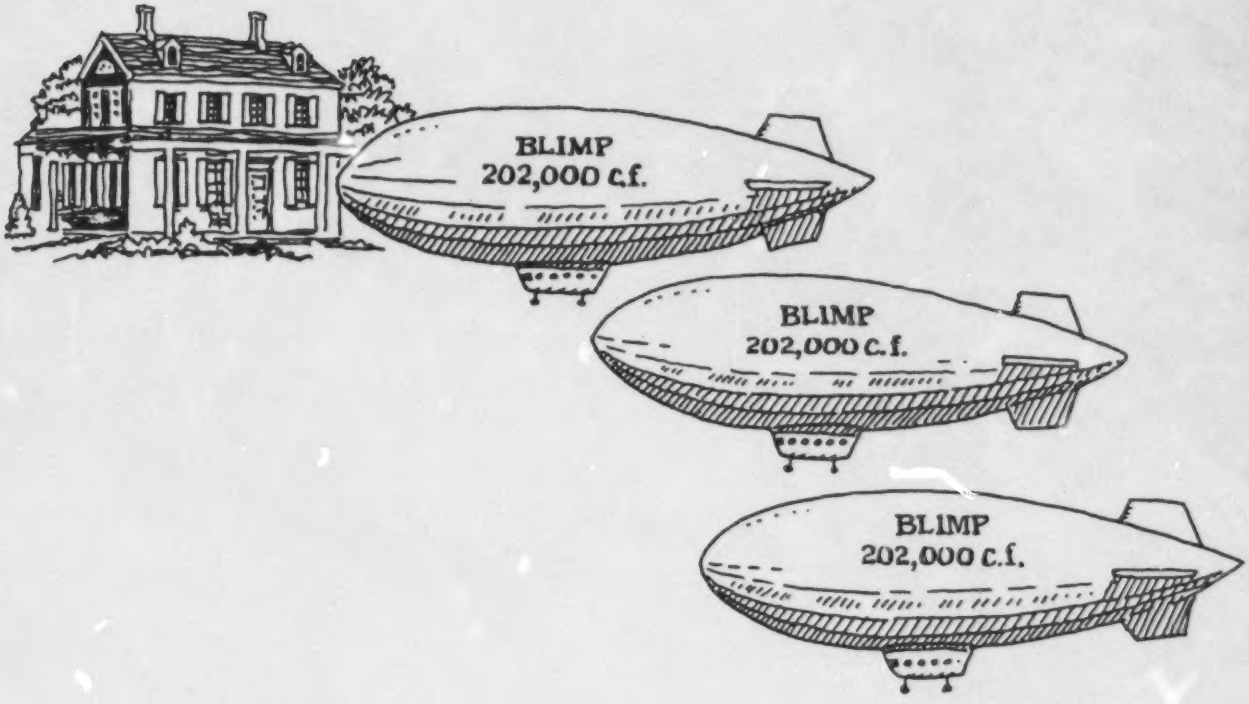
SOLAR HOMES



A HOME EQUIPPED WITH AN ACTIVE SOLAR HEATING SYSTEM

A PARTIALLY EARTH-SHELTERED PASSIVE SOLAR HOME


HOUSES UNDERGROUND
(DIRT CHEAP!)
ENJOY WARM WINTERS, COOL SUMMERS.
NATURAL ENERGY SAVING FEATURES OF INSULATION, CAULKING AND WEATHERSTRIPPING.
SMALLER, LESS EXPENSIVE HEATING AND COOLING SYSTEMS.
LESS WINDOWS FOR HEAT LOSS.
SUITABLE ONLY FOR CERTAIN CLIMATES AND TERRAINS.
DIFFICULT TO CONTROL HUMIDITY.
NOT SUITABLE FOR LAND AT OR NEAR SEA LEVEL.
FEWER WINDOWS FOR VISIBILITY
FEWER ENTRY + EXIT POINTS.
INITAL CONSTRUCTION MORE EXPENSIVE.
COMPLEXITY IN MEETING LOCAL CODES AND ORDINANCES.
HOME SWEET HOME



Enough air passes through an average home in 24 hours to fill up three Goodyear blimps.

AIR LEAKAGE TEST RESULTS

Air infiltrates through any cracks or spaces open to the outside of the home. For example, 1/16 inch crack around the sides and top of a door is equal to a 4 x 4 inch hole.

Texas Power and Light Company, in connection with Texas A & M University and Princeton University, tested fifty homes in the Dallas area to pinpoint sources of air infiltration. The results are shown below.

The findings included:

1. The leakage under the sole plate is typically the largest source of air infiltration, contributing an average of 25%. (The sole plate, which is also knows as the base plate, is the bottom 2 x 4 or 2 x 6 in your home's wall construction.)

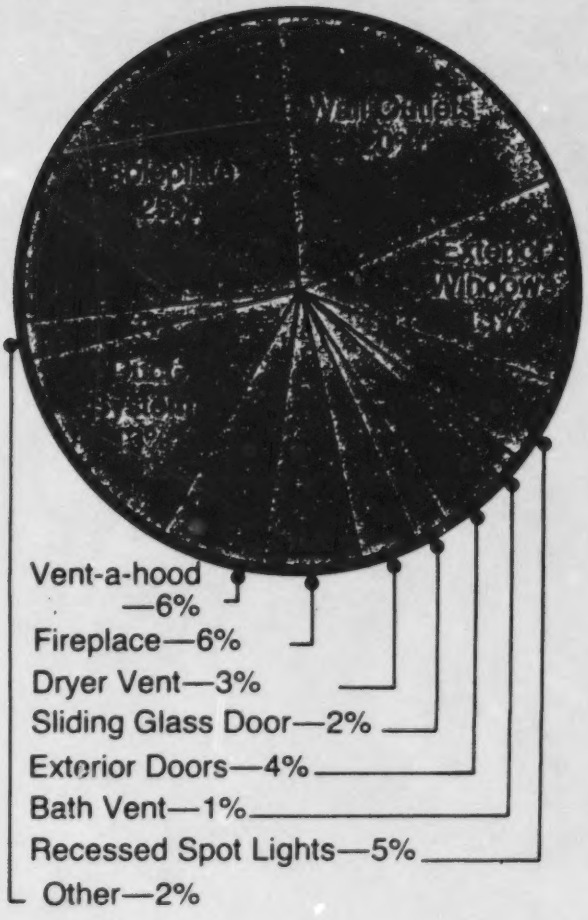
2. Wall outlets are responsible for 20% of air infiltration in Texas homes. This is more than for doors and windows combined. (Air follows the wiring through the studs and cavities of your walls, and moves in and out of your home through the plug and switch plates.) This is true of wiring on both exterior and interior walls.

3. Air infiltration through duct systems and exterior windows accounted for 13% leakage each.

4. Loss of air through:

Vent-a-hood	6%
Fireplace	6%
Dryer Vent	3%
Sliding Glass Doors	2%
Exterior Doors	4%
Bath Vent	1%
Recessed Spot Lights	5%
Other	2%

Air Leakage Test Results for Average Home of 1,728 Sq. Ft.



Source: Texas Power and Light Co.

TESTING FOR AIR LEAKAGE

1. The Draft Gauge

Variation 1: (See figure 1)

Materials Needed:

Metal clothes hanger, a plastic bag (or a piece of light tissue paper), a pair of scissors and two clothes pins.

Directions:

Cut the plastic bag down each side and wrap one end over the cross-bar of the clothes hanger. Use the clothes pins to fasten the bag to the bar.

To check for drafts, hold the gauge steady by the handle of the hanger with the plastic bag close to the edge of the frame. If a breeze is moving in or out, the plastic will show you where a better seal is needed. Use the gauge in all suspected areas, such as around windows and doors. You will be surprised to discover how many spots need to be sealed.

Figure 1

Variation 2: (See figure 2)

Materials Needed:

Pencil, scotch tape, plastic food wrap.

Directions:

Tape the wrap to the pencil as illustrated.

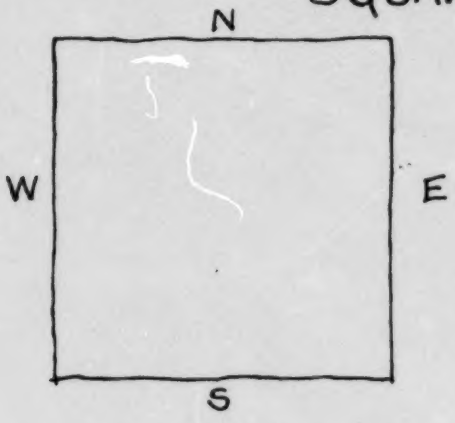
Proceed to check for drafts as described in variation 1.

SHAPE PLANNING CONCEPTS

The optimum shape is one which has minimal heat gain in summer and minimal heat loss in winter. Consider three (3) factors when determining optimum shape:

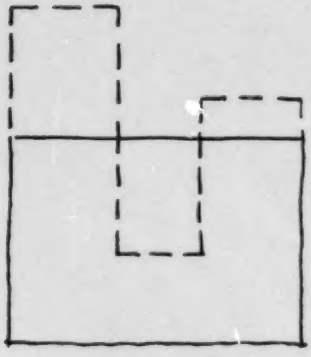
1. volume to surface ratio
2. solar exposure
3. potential for insulation

SQUARE



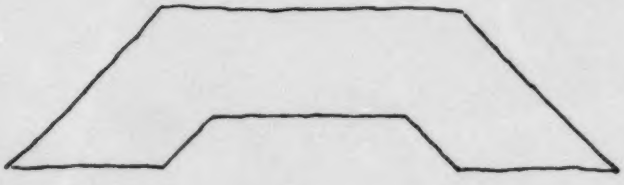
1. Minimize east and west facing walls
2. Floor plan allows for easy zoning of rooms

RECTANGULAR



1. Requires less perimeter wall and thus lowers heat gain and loss

ELONGATED

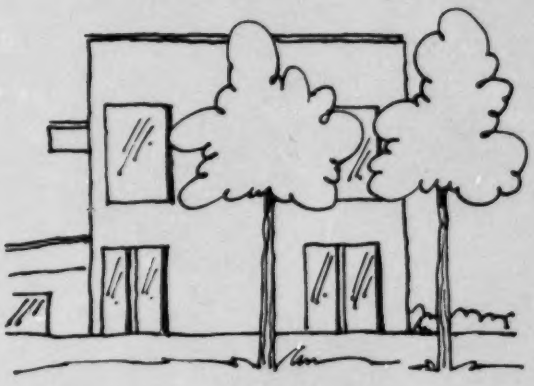


1. Allow for maximum summer wind exposure

SHAPE PLANNING CONCEPTS

Simplicity is the best guideline for the design of passive buildings. The building should provide the most living space with a minimum of surface area, joints, and corners. A spherical shape has the advantage of enclosing the maximum volume with a minimum of exterior surface area. Regrettably, or fortunately, depending on your point of view, most people do not wish to live in spheres.

The next most efficient form is the cube. Cube-like shapes provide high-volume-to-wall-area ratio resulting in the use of fewer building materials and less wall area for heat loss and gain.



Since spheres and cubes are normally unacceptable, a good alternative is a rectangular shape elongated along the east-west axis. This form has two distinct advantages. One, it maximizes the area for solar collection along the south wall while reducing the east and west walls exposed to summer heat gains in the morning and afternoon. And two, it allows easy distribution of solar energy from the south side to the north side and facilitates natural cross ventilation.

As the building form becomes more complex, the relative amount of surface area increases. Also the number of joints, intersections and "wind traps" is increased. The consequences are higher construction costs, greater area for heat loss or gain and higher infiltration. A simple rectangle may not be acceptable in all cases, but remember, keep it simple.

SITE PLANNING GUIDELINES FOR ENERGY CONSERVATION

SITE SELECTION

*For the purpose of solar radiation utilization, buildings should be on the south or west slopes and not the north slope.

*Give the option, all structures should be sited as high as possible on sloping land masses.

*If possible building sites in fog gaps, water gaps, and openings in landmasses should be avoided.

*The climatic effects of large land masses may be modified to a certain extent by microclimatic control through manipulation of smaller land forms, vegetation, and archtectural elements in the landscape.

*Site should be selected as near to large water bodies, with their modifying influences, as possible.

*Sites should be selected to avoid cold west and north winter winds.

BUILDING SITING AND ORIENTATION

*Buildings shold be placed so as to minimally disturb the existing natural land forms of the site.

*Buildings should be sited to avoid removing natural vegetation.

*Locate buildings to be cooled by natural air flows across open bodies ocontrol f water, large open spaces, and on valley floors and slopes.

*Avoid glare and heat build-up by planting between a structure and the west setting sun over a body of water.

INTEGRATION OF BUILDING AND SITE

*In hot humid regions such as the South, the dwelling unit should be elevated and opened as much as possible to take advantage of cooling breezes to reduce dampness and humidity.

*Site development should reflect as much as possible indigenous forms and materials in paving, walls, fences, canopies, fountains, pools, and accessories.

SITE PLANNING

*Roads on the site should be oriented to avoid winter winds and to channel summer breeezes as much as possible.

*Buildings, fences, walls, hedges and other plantings should be located so as to control unwanted winter winds.

*Streets, patios, walkways, and paved surfaces should be located on the natural cool side of structures to avoid heat buildup.

SITE DESIGN

*Deciduous trees should be used for summer shading effects and for winter sun penetration.

*Vines growing on walls, trellises or canopies are effective in shading south south and west walls.

*Decks provide a less reflective surface than hard paving materials and have the advantage of underneath use circulation.

*Use earth forms to shade and screen the exposed walls of buildings.

*Do not use vegetation, walls, or fences to dam cold air flow.

*Lawns and large areas of grass and ground cover should be used in the immediate area of structures because these materials have the capability of remaining at a constant temperature throughout the day.

*Employ medium colors on sun surfaces and reserve dark colors for recessed and protected areas.

*Small trees, hedges, and walls should be placed with ten feet of window openings to help funnel beneficial breezes through the dwelling unit.

*Create sun pockets for winter time outdoor living along south facing walls which are protected from northern winds.

1. Sun exposure very brief, if any.

2. Little sunshading needed.

3. Overhang can be minimum.

1. Sun exposure is short but intensified by high air temperature and low angle

Solutions (in order of effectiveness)

A. Sunshading by walls, trellises, lattice, high fences, low trees, etc.

B. Porch or veranda.

C. Attached carport or garage

D. Awnings

E. Minimum Glass Area

1. Sun exposure is sustained and intensified by day's hottest air.

2. Both tall and medium trees needed for shade.

Solutions (in order of effectiveness)

A. Attached carport or garage

B. Porch or veranda.

C. Glass area fully shaded.

D. Storage cabinets in wall.

E. Awnings or reflective heat

1. Sun exposure is short and intensity is partly relieved by cool air.

2. Overhang and reflective screens ineffective.

3. Low trees or hill give valuable shade.

Solutions (in order of effectiveness)

A. Sunshading by walls, trellises, lattice, high fences, low trees, etc.

B. Awnings

1. Sun exposure sustained and is intense.

2. Both tall and medium trees are needed for shade.

Solutions (in order of effectiveness)

A. Porch or veranda

B. Awnings

C. Reflective screens

D. Recommended overhang

1. Sun is almost overhead and wall absorption is moderate.

2. Exposure is sustained and intense.

Solutions (in order of effectiveness)

A. Recommended overhang.

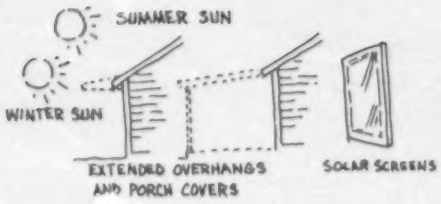
B. Reflective screens

against wall.

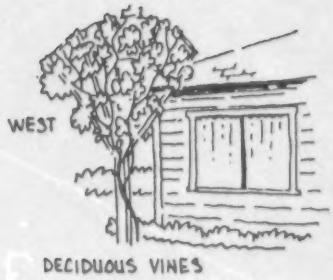
C. Large glass area (if used) under recommended overhang.

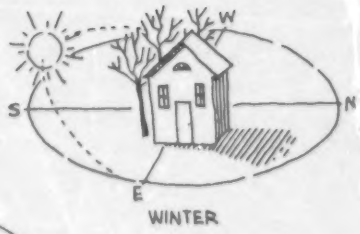
D. Awnings

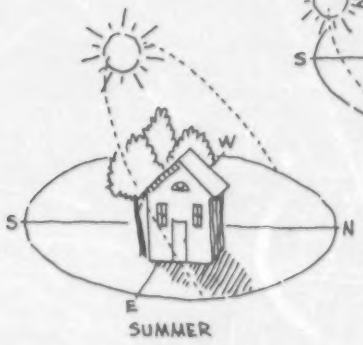
E. Avoid slabs reflecting heat against wall.

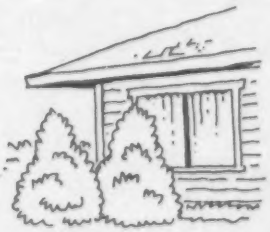


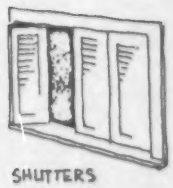
VARIOUS METHODS OF SHADING

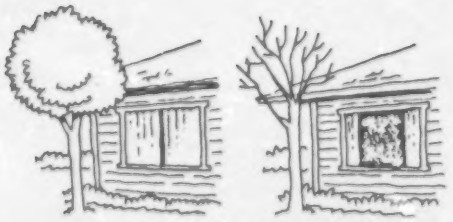




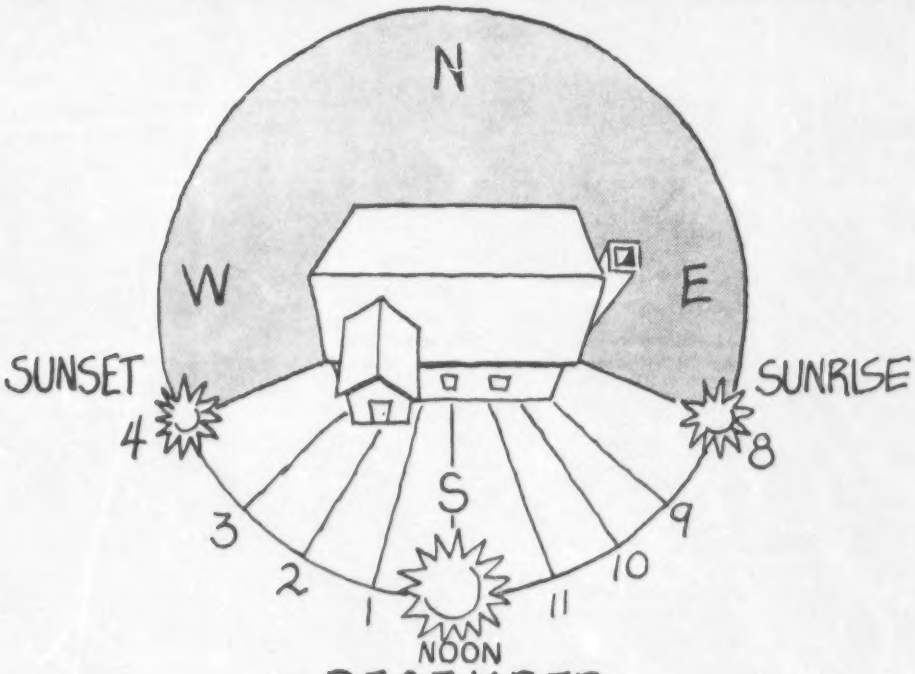




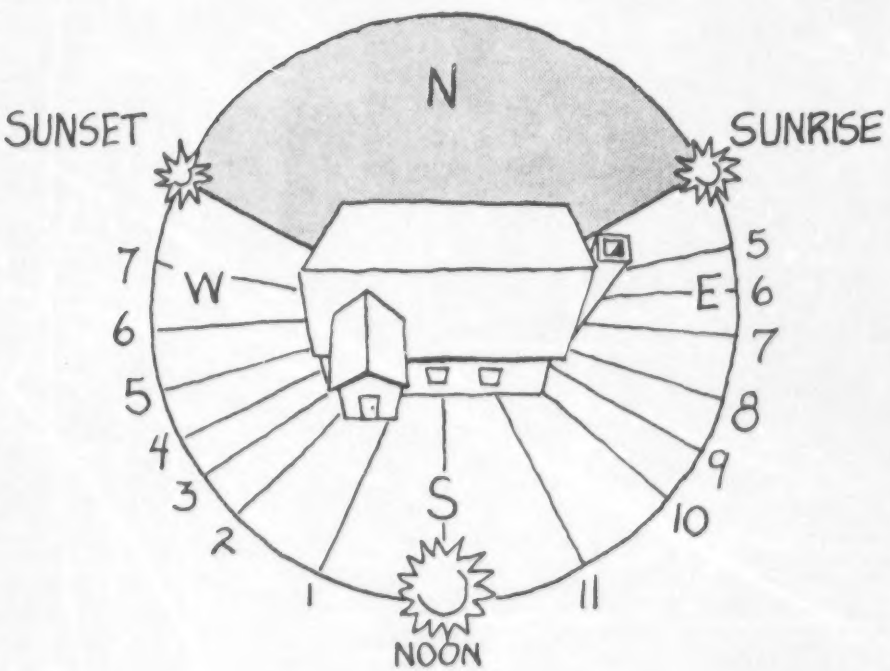




SUN ORIENTATION — HOURLY DIRECTION



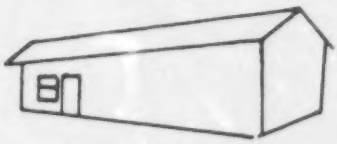
DECEMBER

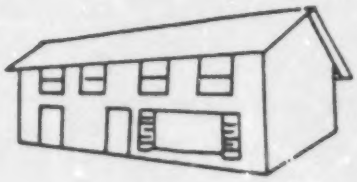


JUNE

HOUSE ORIENTATION

Instructions: Determine the best orientation for each floor plan. Be prepared to justify your answers.





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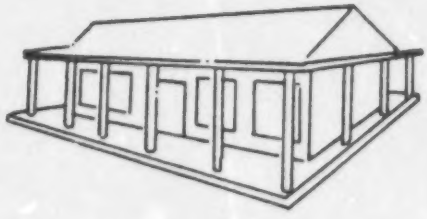

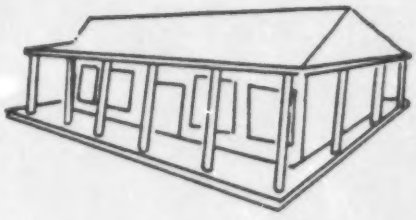

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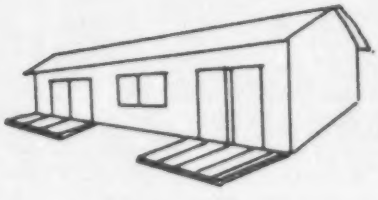

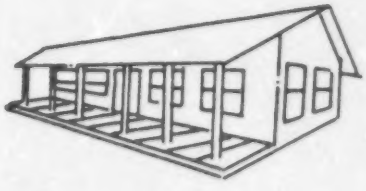

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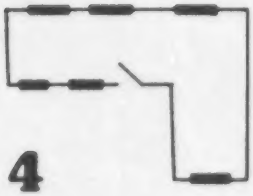

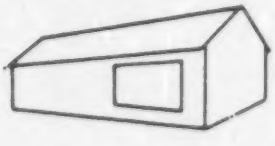

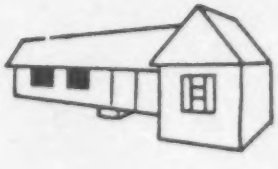

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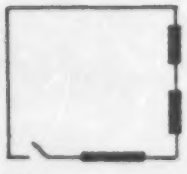
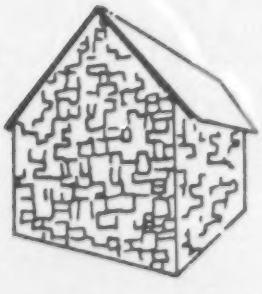
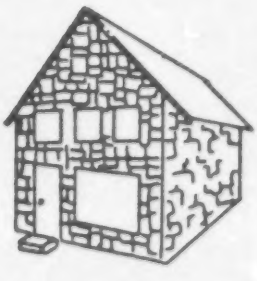
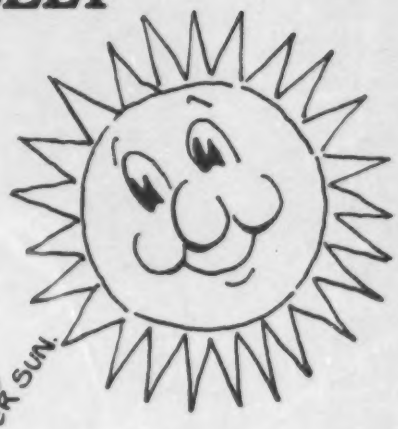






5

USE THE SUN WISELY



NEW HOMES

- MINIMIZE EAST AND WEST WINDOWS.
- PLAN WINDOWS ON NORTH AND SOUTH TO ESCAPE SUMMER SUN BUT CAPTURE WINTER SUN.
- BUILD WIDE PORCHES OR VERANDAS.

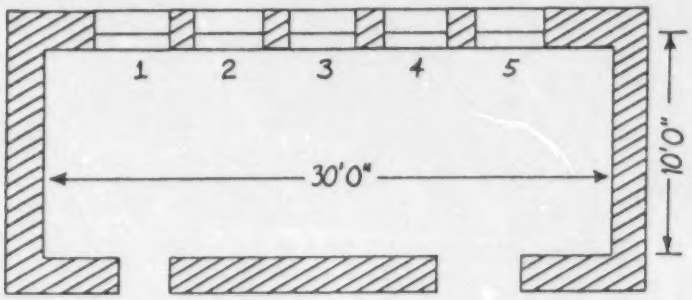
EXISTING HOMES

- LANDSCAPE WITH DECIDUOUS TREES AND VINES.
- SHADE WITH AWNINGS, REFLECTIVE FILM OR SOLAR SCREENS

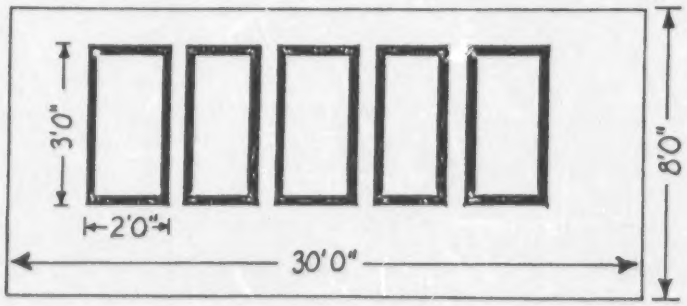
WINDOW AREA CHECK

Since glass has much less insulating value than a wall, it is wise to use as little glass (windows) as possible to conserve energy requirements for cooling and heating. The general recommendation for glassed area is: 10 percent, or no more than 20 percent, of the total square footage of the home.

It is a simple arithmetic formula to determine if your home or classroom meets these guidelines.



From the elevation, we see the total glassed area is 30 square feet, and the floor area is 300 square feet.



To determine the percentage of glassed area, you simply divide:

$$\frac{30 \text{ glassed area}}{300 \text{ floor area}} = .10 \text{ or } 10\%$$

NOTE: If you measure windows on your home or classroom, remember to measure glassed area only.

Adapted from: Energy Management Strategies for Colorado Home Economics Teachers, Public Service Company of Colorado, November, 1979.

WINDOW AREA WORKSHEET
FLOOR PLAN # _____

A. How many windows are too many windows? Evaluate the window area of the following floor plans to see if the glass area is within the guidelines of 10% to 20% of the floor area. If the glass area is over 20%, there is too much heat loss.

$$\frac{\text{glassed area}}{\text{floor area}} = \_\_\_\_\_ = \_\_\_\_\_\%$$

If the total window area is 20% or over, what recommendations can you make?

a.

b.

c.

d.

B. Will there be too much sun coming through on the east and west sides of the home? Evaluate the window area of the east and west sides. If the amount of unshaded windows on the east and west is over 4%, then the window area needs to be modified in some way.

$$\frac{\text{unshaded glassed area on east}}{\text{floor area}} = \_\_\_\_ = \_\_\_\_\%$$

$$\frac{\text{unshaded glassed area on west}}{\text{floor area}} = \_\_\_\_ = \_\_\_\_\%$$

East _____% + West _____% = _____% Solar Glass

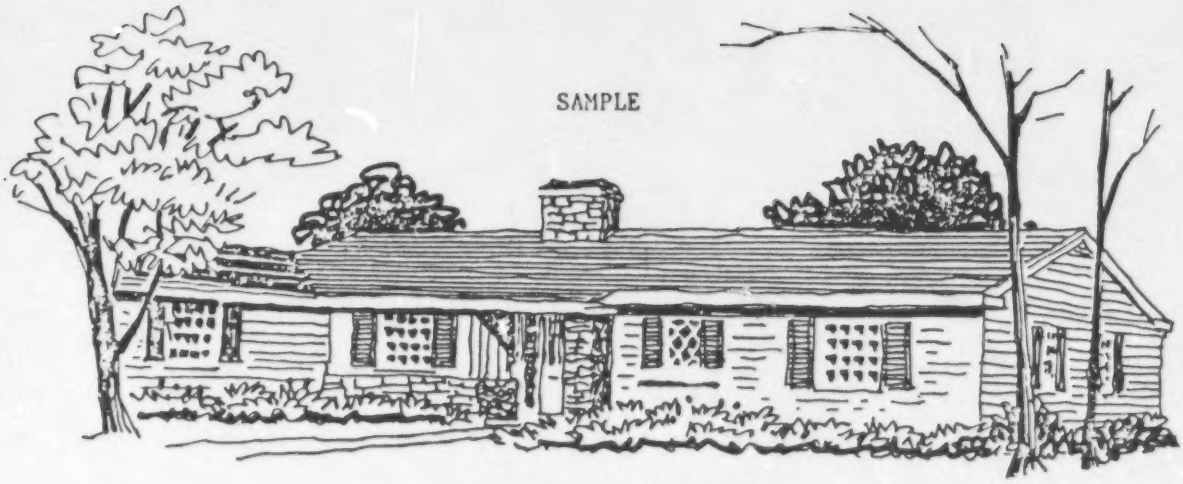
If any of the window area on the east and west needs to be changed or shaded, what recommendations can you make?

a.

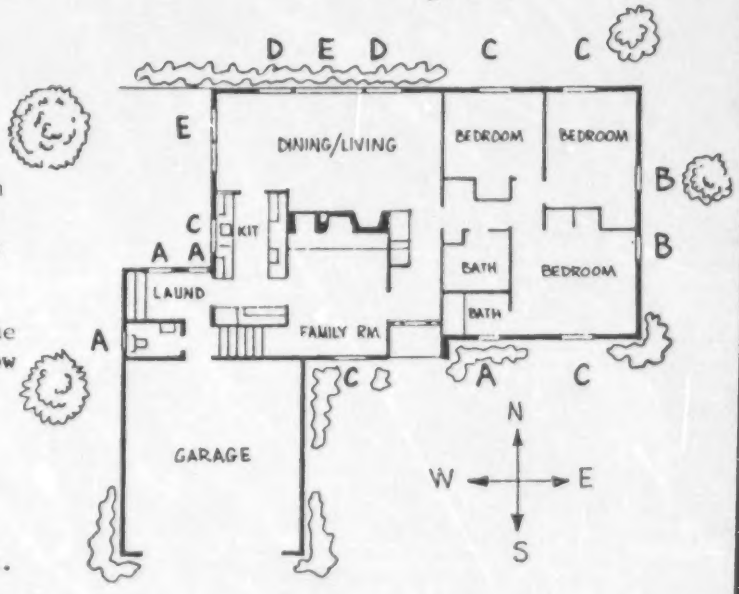
b.

c.

d.



Living Area:
1,484 Sq. Ft.



INSTRUCTIONS: Use a piece of scratch paper to figure on.
TOTAL SQUARE FEET OF GLASS PROBLEM A: Using the Window Schedule, determine the total amount of window area on north, south, east, and west. Use the answer to work Problem A on the Window Area Worksheet.

N	S	E	W
D=18	C=16	B=12	E=26
E=36	A= 6	B=12	C=16
D=18	C=16	24 sq.ft.	A= 6
C=16	38 sq.ft.		58 sq.ft.
C=16		116	
A= 6		38	
A= 6		24	
116 sq.ft.		58	
		236 Total Square Feet	

WINDOW SCHEDULE
Width x Length = Square Feet

(A)	2' x 3'	= 6
(B)	3' x 4'	=12
(C)	4' x 4'	=16
(D)	3' x 6'	=18
(E)	6' x 6'	=36

EAST AND WEST GLASS UNSHADED
PROBLEM B: Next, look at the windows on the east and west. Are there any windows shaded by a tree or covered porch indicated on the drawing?
Figure the total square feet of windows not shaded.
Use the answer to work Problem B on the Window Area Work Sheet.

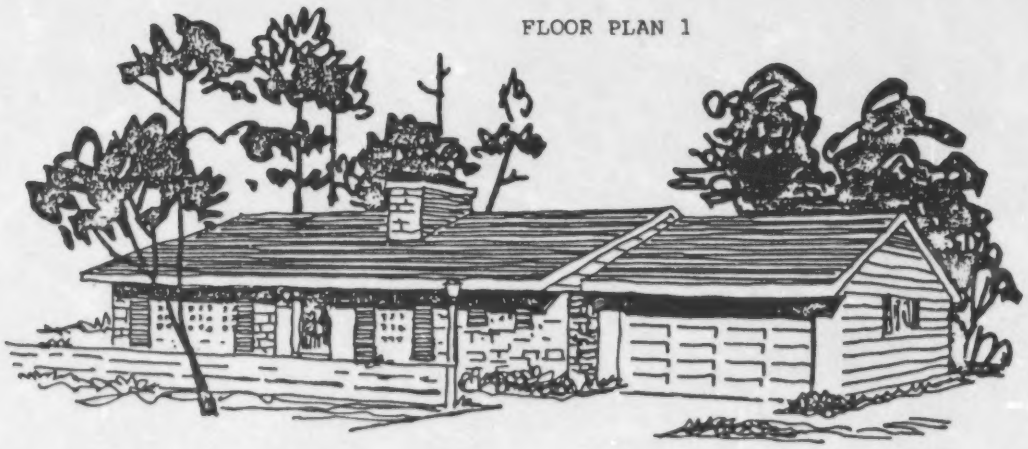
1. East 24 total
-12 shaded
12 East unshaded

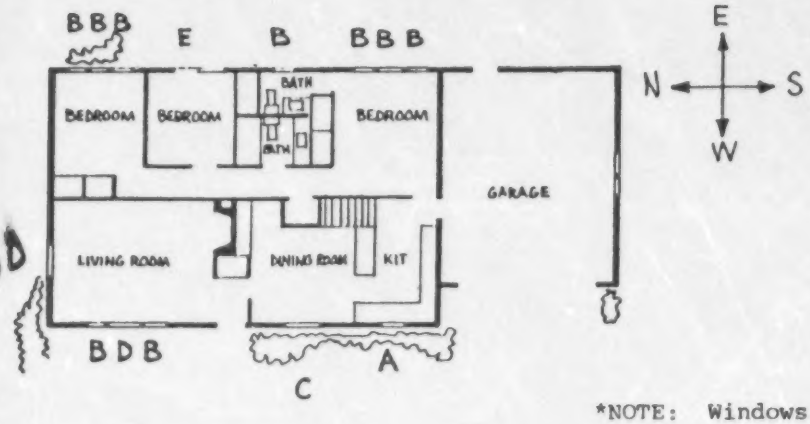
2. West 58 total
-36 shaded
22 West unshaded

Source: House Beautiful's Building-Manual, Vol. 80 No. 3, Fall, 1980

WORKSHEET

FLOOR PLAN 1





Living Area:
1,232 Sq. Ft.

WINDOW SCHEDULE
(Key to Size of Windows)
Width x Length = Square Feet

(A)	2' x 3'	= 6
(B)	2' x 4'	= 8
(C)	3' x 4'	= 12
(D)	4' x 4'	= 16
(E)	6' x 6'	= 36

*NOTE: Windows in Garages are not counted.

INSTRUCTIONS: Use a scratch sheet of paper to figure answers.

TOTAL SQUARE FEET OF GLASS

PROBLEM A: Using the Window Schedule above, determine the total amount of window area on north, south, east and west. Use the answer to work Problem A on the Window Area Worksheet. Refer to Sample Floor Plan.

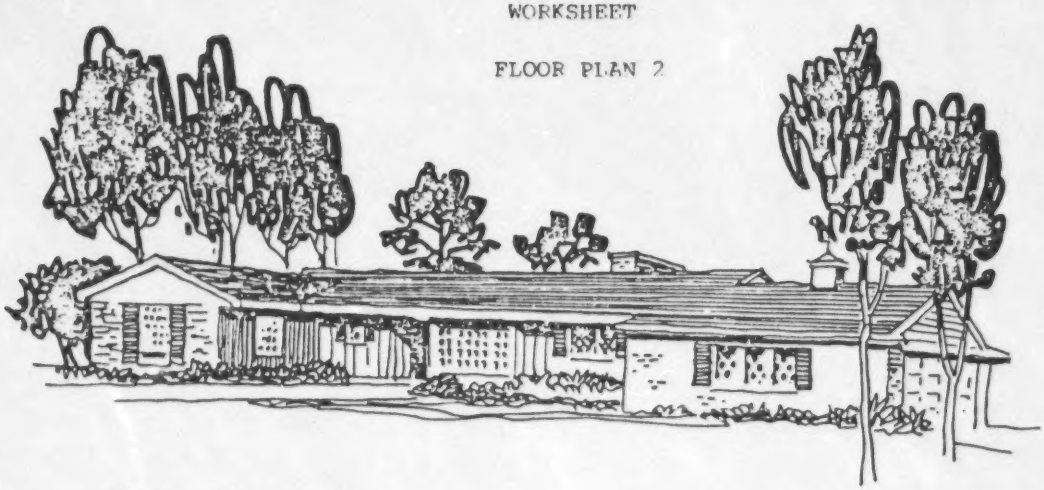
EAST AND WEST GLASS UNSHADED

PROBLEM B: Next, look at the windows on the east and west. Are there any windows shaded by a tree or covered porch indicated on the drawing? Figure the total square feet of windows not shaded. Use the answer to work Problem B on the Window Area Worksheet.

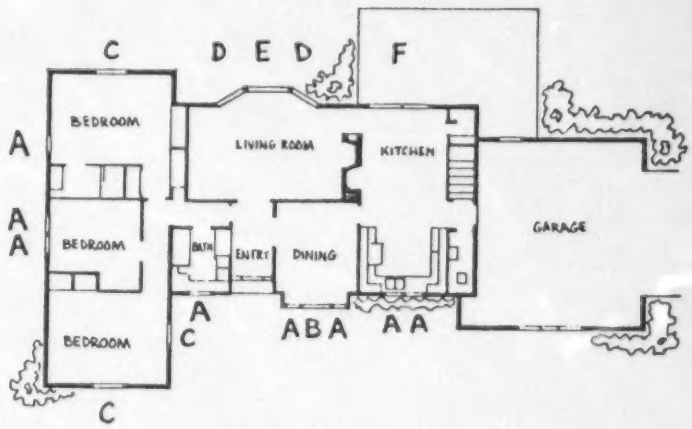
SOURCE: HOUSE BEAUTIFUL's BUILDING-MANUAL, Vol. 80 No. 3, Fall, 1980.

WORKSHEET

FLOOR PLAN 2

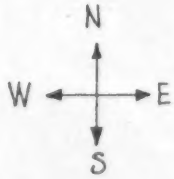


Living Area:
1,616 Sq. Ft.



WINDOW SCHEDULE
WIDTH X LENGTH = SQUARE FEET

(A)	2' x 3'	= 6
(B)	3' x 3'	= 9
(C)	3' x 4'	= 12
(D)	2' x 4'	= 8
(E)	4' x 4'	= 16
(F)	6' x 6'	= 36



*NOTE: Windows in Garages are not counted.

INSTRUCTIONS: Use a scratch sheet of paper to figure answers.
TOTAL SQUARE FEET OF GLASS PROBLEM A:

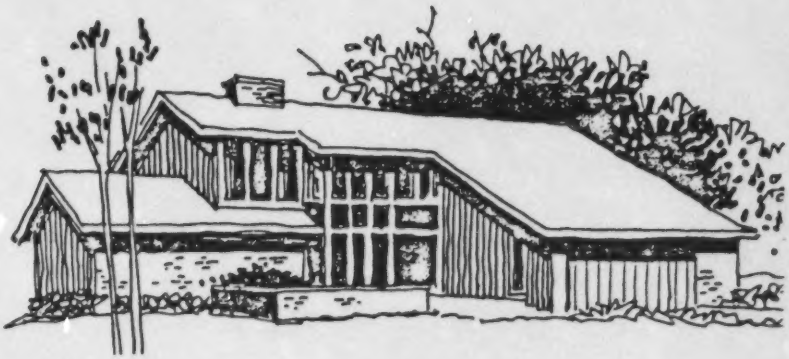
Using the Window Schedule above, determine the total amount of window area on north, south, ease and west. Use the answer to work Problem A on the Window Area Worksheet. Refer to Sample Floor Plan.

EAST AND WEST GLASS UNSHADED PROBLEM B:

Next, look at the windows on the east and west. Are there any windows shaded by a tree or covered porch indicated on the drawing? Figure the total square feet of windows not shaded. Use the answer to work Problem B on the Window Area Worksheet.

SOURCE: HOUSE BEAUTIFUL's BUILDING-MANUAL, Vol. 80 No. 3, Fall, 1980.

FLOOR PLAN 3

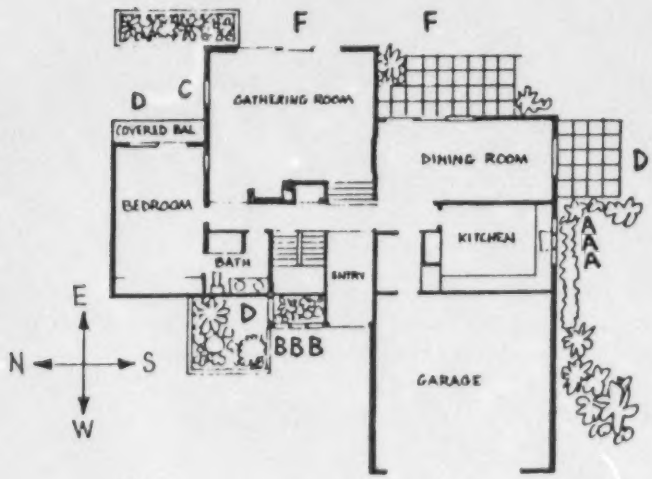


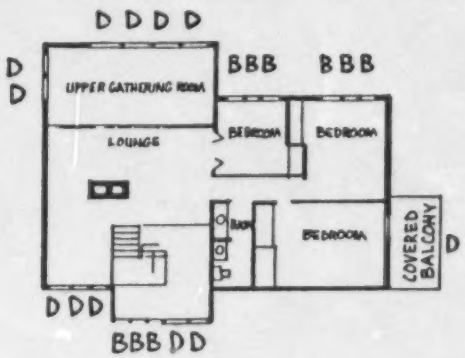
WINDOW SCHEDULE
WIDTH X LENGTH = SQUARE FEET

(A)	2' x 3'	= 6
(B)	2' x 6'	= 12
(C)	3' x 4'	= 12
(D)	3' x 6'	= 18
(E)	4' x 6'	= 24
(F)	6' x 6'	= 36

*NOTE: Windows in Garages are not counted.

First Floor: 1,616 Sq. Ft.
Second Floor: 997 Sq. Ft.





INSTRUCTIONS: Use a scratch sheet of paper to figure answers.

TOTAL SQUARE FEET OF GLASS

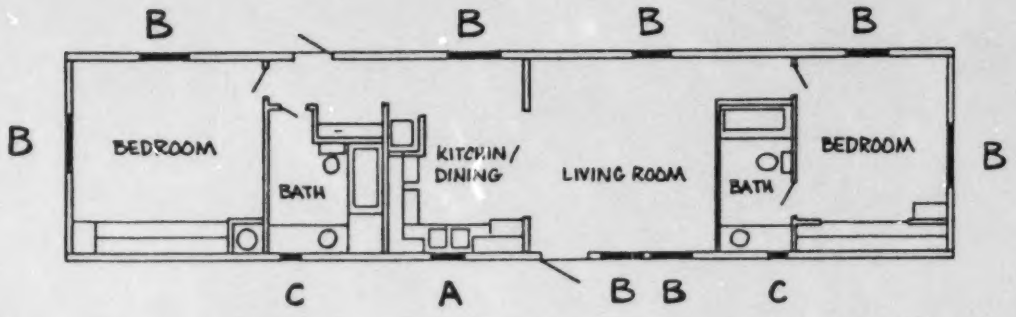
PROBLEM A Using the Window Schedule above, determine the total amount of window area on north, south, east and west. Use the answer to work Problem A on the Window Area Worksheet. Refer to Sample Floor Plan.

EAST AND WEST GLASS UNSHADED

PROBLEM B: Next, look at the windows on the east and west. Are there any windows shaded by a tree or covered porch indicated on the drawing? Figure the total square feet of windows not shaded. Use the answer to work Problem B on the Window Area Worksheet.

SOURCE: HOUSE BEAUTIFUL's BUILDING-MANUAL, Vol. 80 No. 3, Fall, 1980.

FLOOR PLAN 4
MOBILE HOME



Living Area:
896 Sq. Ft.

WINDOW SCHEDULE

Width x Length = Square Feet

(A) 2' x 3' = 6
(B) 3' x 4' = 12
(C) 1' x 2' = 2

INSTRUCTIONS: Use a scratch sheet of paper to figure answers.

TOTAL SQUARE FEET OF GLASS

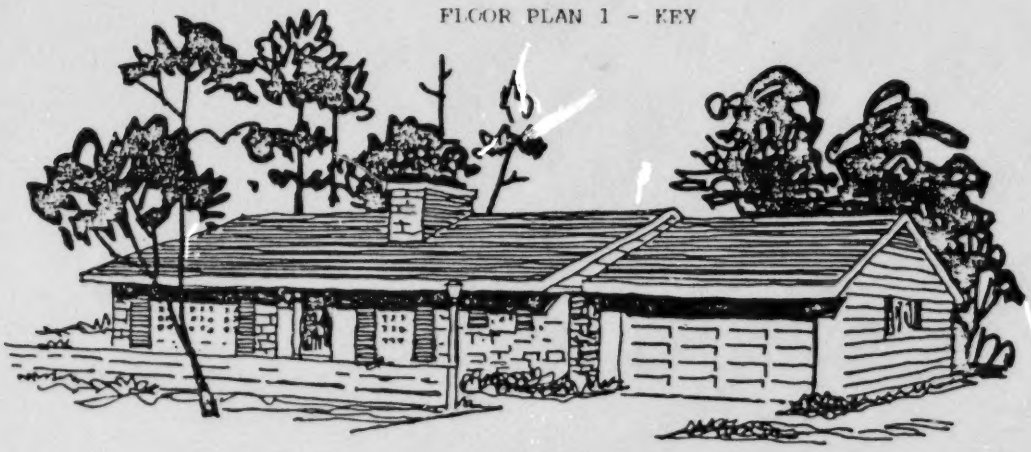
PROBLEM A Using the Window Schedule above, determine the total amount of window area on north, south, east and west. Use the answer to work Problem A on the Window Area Worksheet. Refer to Sample Floor Plan.

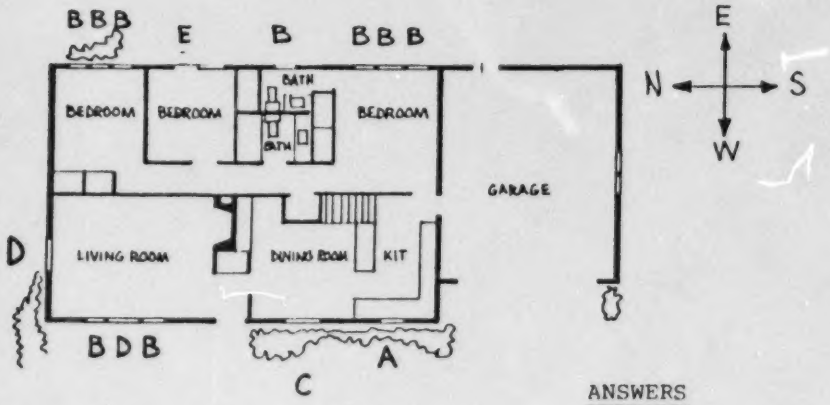
EAST AND WEST GLASS UNSHADED

PROBLEM B: Next, look at the windows on the east and west. Are there any windows shaded by a tree or covered porch indicated on the drawing? Figure the total square feet of windows not shaded. Use the answer to work Problem B on the Window Area Worksheet.

SOURCE: Commodore Home Systems, Inc., Texarkana, Texas.

FLOOR PLAN 1 - KEY





Living Area:
1,232 Sq. Ft.

ANSWERS

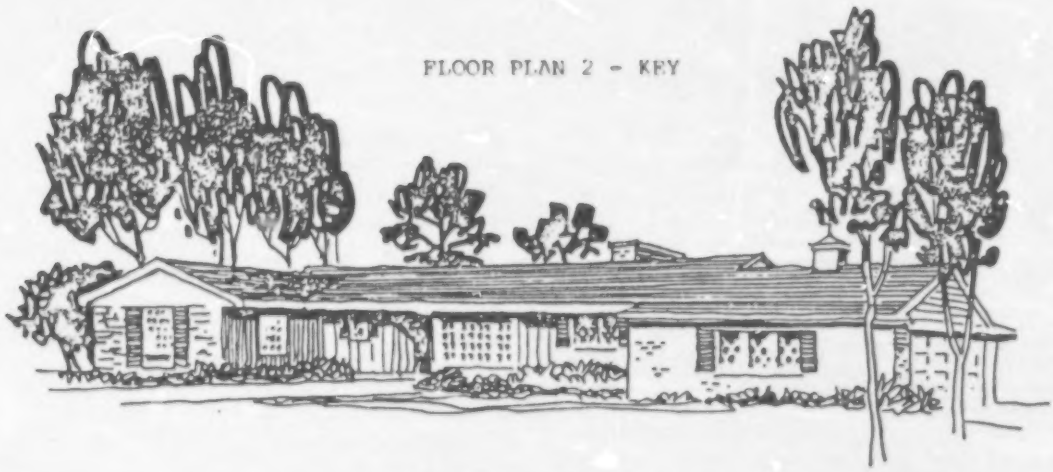
PROBLEM A

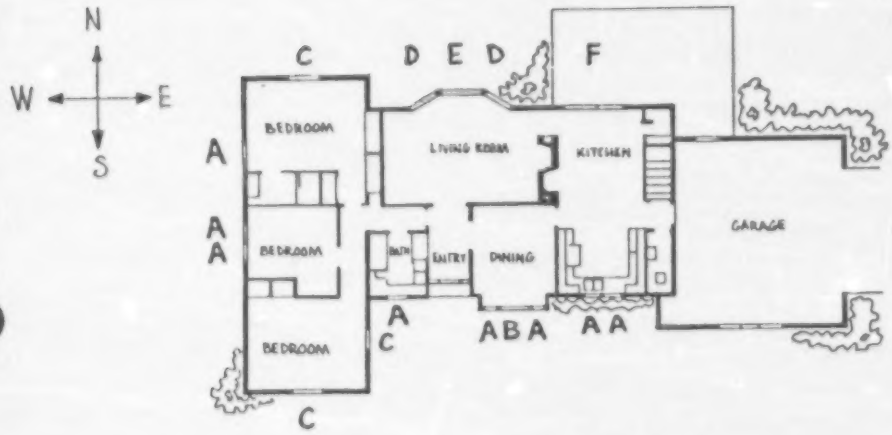
N	S	E	W	
D=16	0	B=8	B=8	16 N
		B=8	D=16	0 S
		B=8	B=8	92 E
		B=36	C=12	50 W
		B=8	A=6	158 Total Sq. Ft.
		B=8	50	
		B=8		
		B=8		
		92		

PROBLEM B

92 East	50 West
- 0 shaded	- 0 shaded
92 unshaded	50 unshaded

FLOOR PLAN 2 - KEY





Living Area:
1,616 Sq. Ft.

ANSWERS

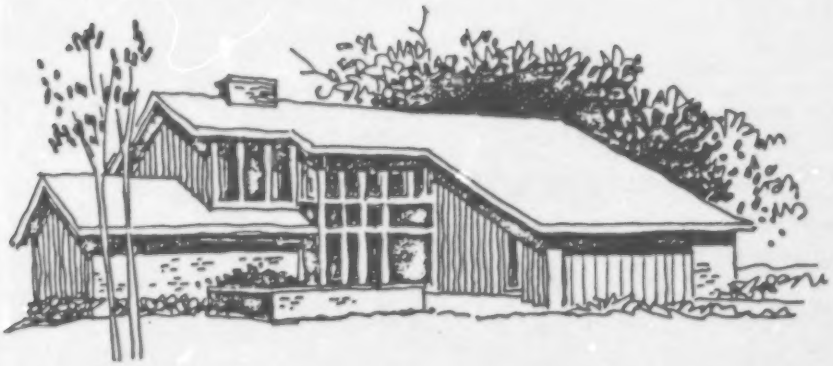
PROBLEM A

N	S	E	W	
C=12	C=12	C=12	A=6	80 N
D=8	A=6		A=6	51 S
E=16	A=6		A=6	12 E
D=8	B=9		18	18 W
F=36	A=6			161 Total Sq. Ft.
80	A=6			
	51			

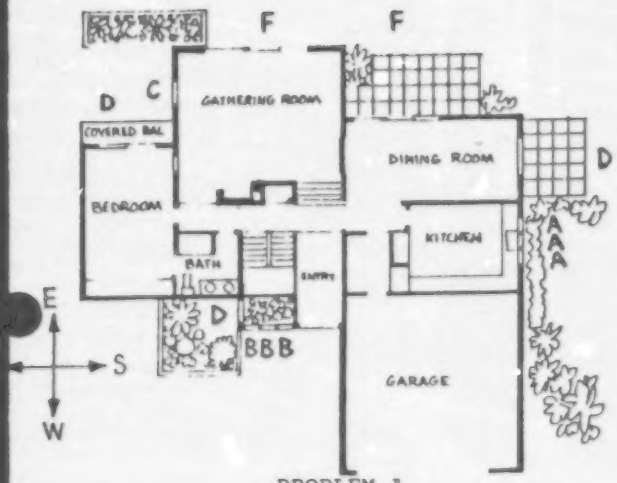
PROBLEM B

18 West	12 East
- 0 shaded	- 0 shaded
18 unshaded	12 unshaded

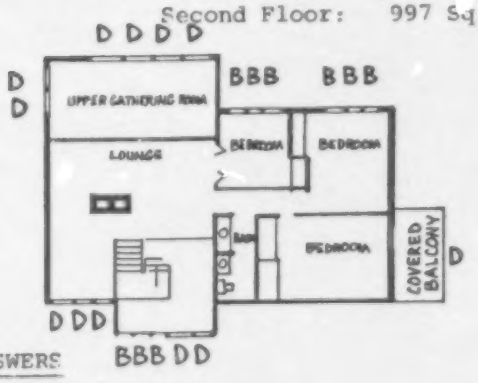
FLOOR PLAN 3 - KEY



First Floor: 1,616 Sq. Ft.
Second Floor: 997 Sq. Ft.



PROBLEM A



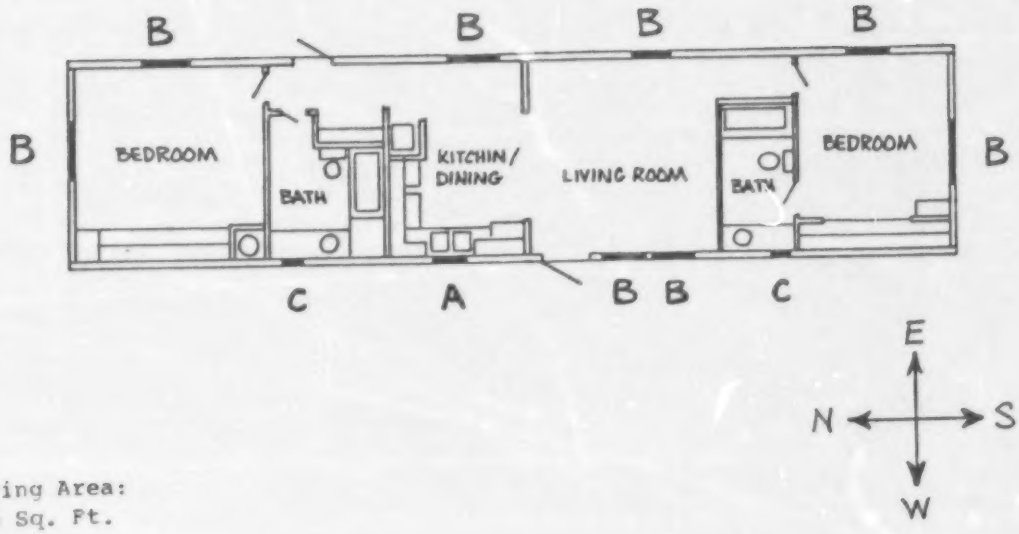
ANSWERS

PROBLEM B

N	S	E	W		
C=12	D=18	D=18	B=12	48	N
D=18	A=6	F=36	B=12	44	S
D=18	A=6	F=36	B=12	234	E
48	A=6	D=18	D=18	162	W
	D=18	D=18	D=18	498	Total Sq. Ft.
	54	D=18	D=18		
		D=18	B=12		
		B=12	B=12		
		B=12	B=12		
		B=12	D=18		
		B=12	D=18		
		B=12	162		
		B=12			
		234			

234 East	162 West
-18 shaded	- 0 shaded
216 unshaded	162 unshaded

FLOOR PLAN 4
MOBILE HOME
KEY



Living Area:
896 Sq. Ft.

ANSWERS

PROBLEM A

N	S	E	W		
B=12	B=12	B=12	C=2	12	N
		B=12	A=6	12	S
		B=12	B=12	48	E
		B=12	B=12	34	W
		48	C=2	106	Total Sq. Ft.
			34		

PROBLEM B

34 West	48 East
- 0 shaded	- 0 shaded
34 unshaded	48 unshaded

KEY

FLOOR PLAN I

A. 158 / 1,232 glassed area / floor area = .13 = 13 %

B. 92 / 1,232 unshaded glassed area on East / floor area = .07 = 7 %

50 / 1,232 unshaded glassed area on West / floor area = .04 = 4 %

East 7 % + West 4 % = 11 % Total Solar Glass

FLOOR PLAN II

A. 161 / 1,616 glassed area / floor area = .099 = 10 %

B. 12 / 1,616 unshaded glassed area on East / floor area = .007 = 1 %

18 / 1,616 unshaded glassed area on West / floor area = .01 = 1 %

East 1 % + West 1 % = 2 % Total Solar Glass

FLOOR PLAN III

A. 498 / 2,516 glassed area / floor area = .20 = 20 %

B. 216 / 2,516 unshaded glassed area on East / floor area = .085 = 9 %

162 / 2,516 unshaded glassed area on West / floor area = .06 = 6 %

East 9 % + West 6 % = 15 % Total Solar Glass

FLOOR PLAN IV

A. 106 / 896 glassed area / floor area = .118 = 12 %

B. 34 / 896 unshaded glassed area on East / floor area = .037 = 4 %

48 / 896 unshaded glassed area on West / floor area = .05 = 5 %

East 4 % + West 5 % = 9 % Total Solar Glass

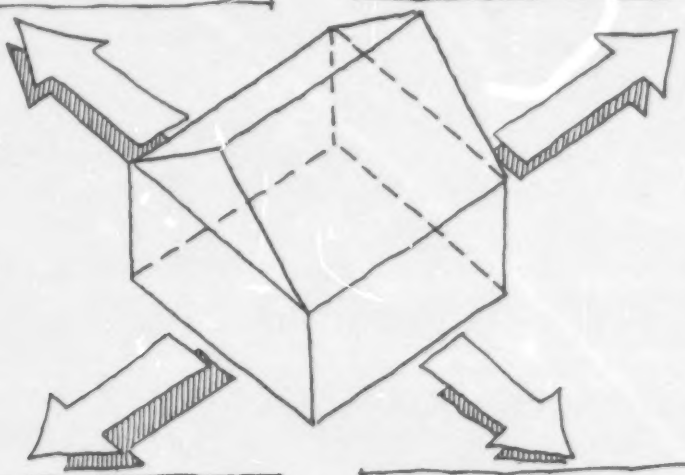
The following information should help you analyze where windows should be placed in order to optimize their thermal performance.

NORTH

Minimize window areas to reduce heat loss. Use small windows for daylighting and ventilation. Shading is not normally needed. Use normal clear glazing.

EAST

Reduce window areas to reduce winter heat loss and morning heat gain during summer. Use small windows for ventilation. Windows in a kitchen or breakfast area provide pleasant morning light. Use vertical shading elements or vegetation for shading. Only very deep horizontal overhangs (porches, carports...) will provide effective shading.



WEST

Avoid large unshaded glass areas to reduce heat loss and gain. During the summer, afternoon heat gains may be a severe problem. Shade glass with vertical elements, vegetation or deep overhangs. Overhangs are less effective on east apd west walls due to low morning and afternoon sun angles. Small, well shaded windows should be used for ventilation. Consider heat absorbing or reflective glazing.

SOUTH

Use this glass for winter heat gain and summer ventilation. Shade glazing with properly sized horizontal overhangs. Glazed area must be matched to the house's thermal load and storage capacity. Use normal glazing or, where glare may be problem, use diffusing glazing.

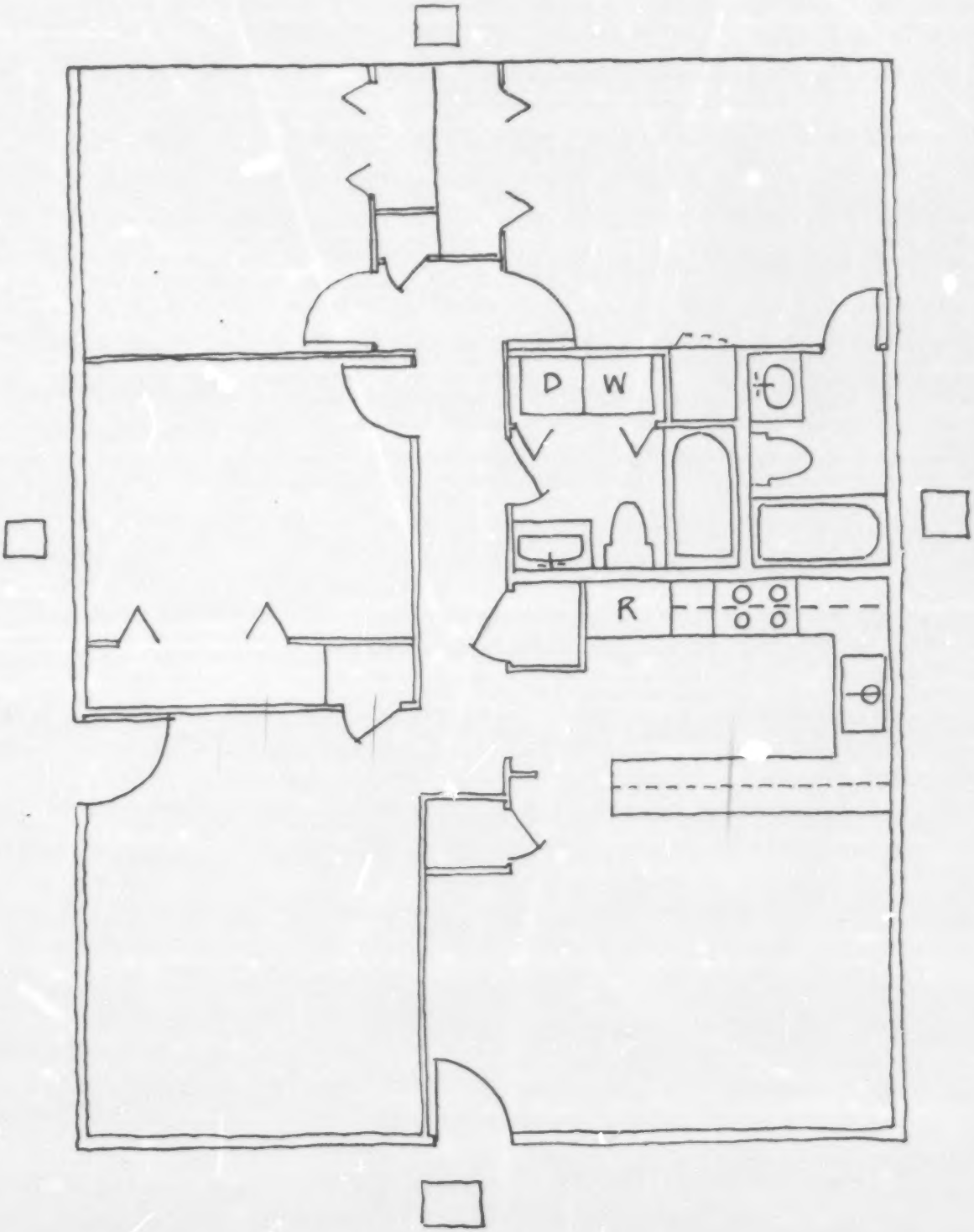
Use clerestory windows to admit light and winter heat into the House. Provide overhangs for summer shading.

Adapted from "Building With Passive Solar".

INSTRUCTIONS:

1. Draw in the exterior glass area for this floor plan. Indicate the type of window or door used.

2. Note house orientation in squares.



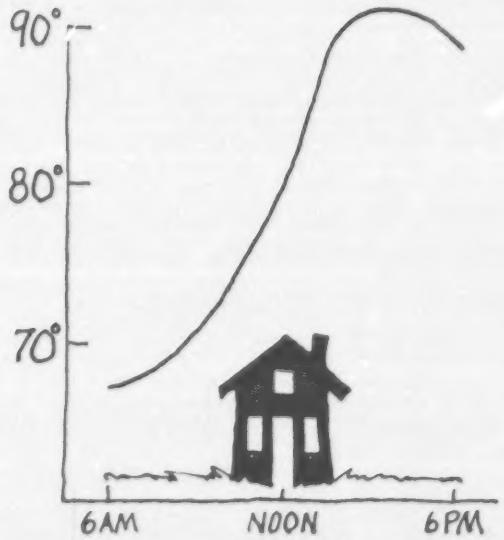
HOW LANDSCAPING HELPS

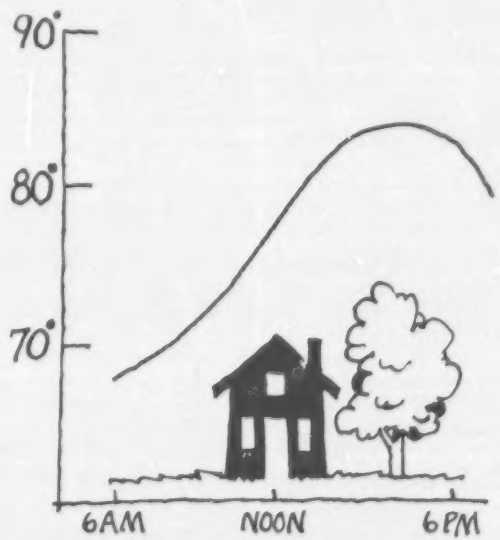
When you landscape for energy efficiency, you help your home by: 1) Reducing the hot sunlight hitting the walls, windows and roof, 2) Cutting down on the wind velocity around the home's outside, which reduces the amount of air infiltration and 3) Modifying the difference in outdoor vs. indoor temperature.

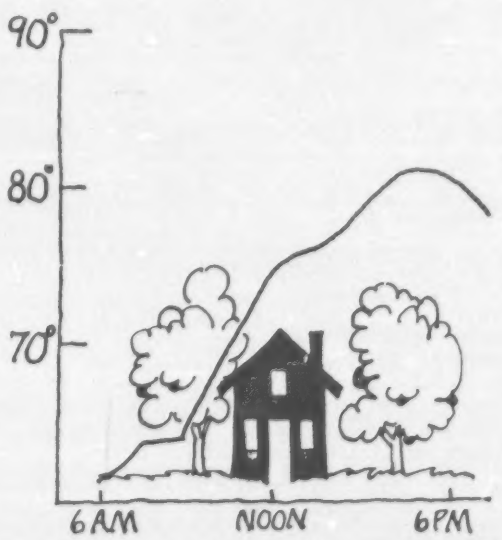
Evergreen trees and large shrubs act as wind breaks on the northern side of the home. Large deciduous trees - those that lose their leaves in winter - on the south, east and west sides shade your house from summer sun; but when their leaves fall, they let winter sun in.

TREES

Free-standing trees provide an effective shading device that can affect not only the walls of a building but also its roof. Deciduous trees let the sun in during the winter and provide shade during the summer, while evergreen trees provide constant shade. As the number of trees increases, their effect on the house will change. A grove of trees will not only provide shade and wind protection but modify outside air temperature through evaporative cooling.



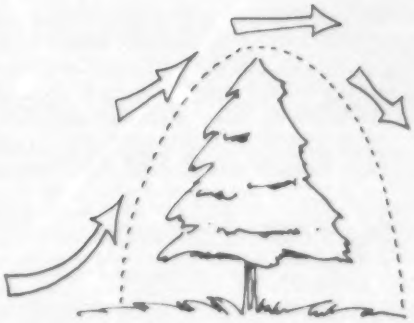




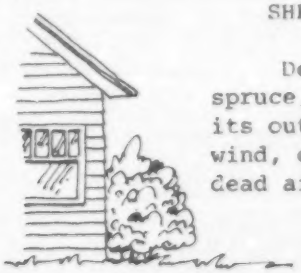
HOW LANDSCAPING HELPS

WINDBREAK

A windbreak can be any barrier to wind; a row of evergreen trees spaced close together, a fence, a wall, or even a garage. A windbreak is used to control wind speed and direction. Depending on the location and design of the windbreak, it can either act as a barrier, reducing wind pressure around a house; or as a funnel, increasing wind pressure and improving ventilation through a house.



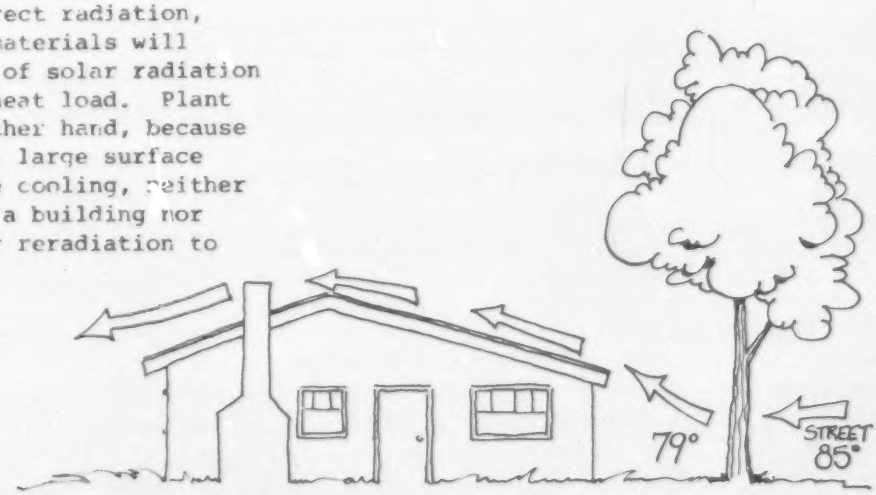
SHRUBS



Dense shrubs such as arborvitae, hemlock or spruce, when planted close to a building, affect its outside surface temperature by blocking the wind, creating shade, and providing an insulating dead air space between the shrub and the building.

GROUND SURFACE

Ground surfaces around houses affect the radiant and conductive heat gains and losses of windows and walls. They reflect solar radiation through windows and cause local changes in outdoor air temperatures by storing warmth and coldness in surrounding materials. Light-colored materials are usually reflective and will increase the heat load immediately by indirect radiation, while dark-colored materials will store large amounts of solar radiation and thus delay the heat load. Plant materials, on the other hand, because of their dark color, large surface area and evaporative cooling, neither reflect heat toward a building nor store heat for later reradiation to the building.



ENERGY-CONSERVING LOCATION FOR LANDSCAPE ELEMENTS

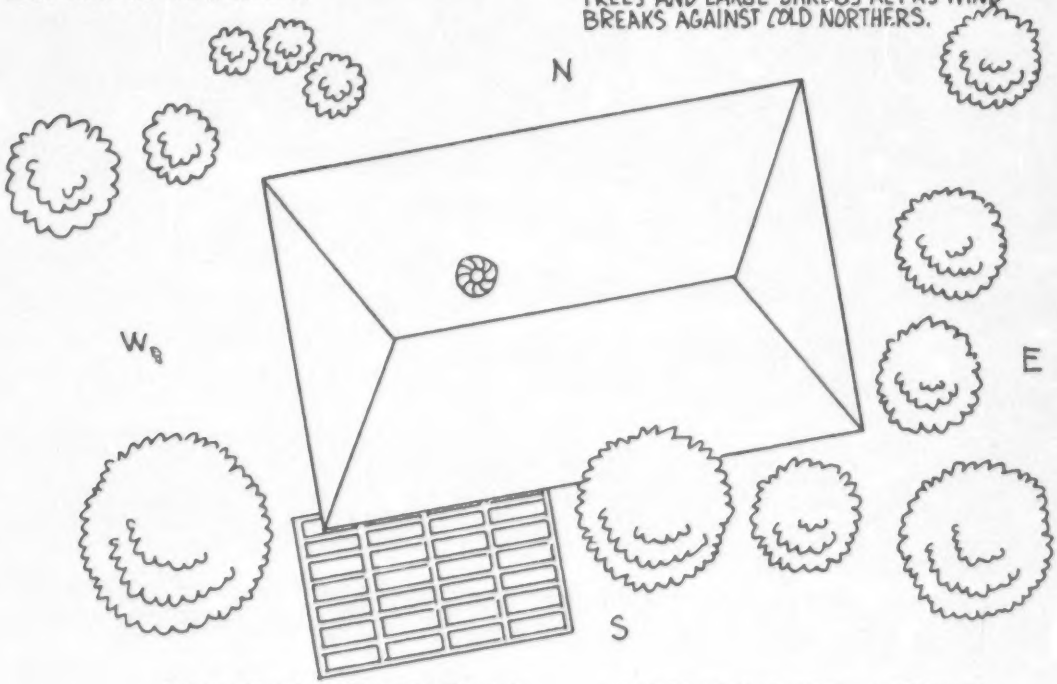
LANDSCAPE ELEMENTS	COLD CLIMATE	TEMPERATE CLIMATE	WARM CLIMATE
Paving	On South	Shaded if on South	Shaded if on East, West and South
Ground Cover or Grass	Negligible Effect on all Sides	On South	On East, West and South
Shrubs Against House Wall	On East, West and North	On East, West & North	On All Sides
Deciduous Shade Tree	Negligible Effect on all Sides	On South & West	On East & West
Evergreen Trees	On East, West and North	On East & West	On East & West
Windbreak (Trees, Bushes, Fences)	On Sides Exposed to Winter Winds	On Sides Exposed to Winter Winds	Undesirable Effect On All Sides
Windbreak Used to Funnel Wind	Undesirable on All Sides	On Sides Exposed To Summer Winds	Where Cross Ventilation is possible

TYPES OF TREES

TREE	GROWTH RATE	OUTSTANDING CHARACTERISTICS
Pecan	Medium	Fruit and shade
Hackberry	Fast	Fast Shade
Sweetgum	Fast	Fall Color
Southern Magnolia	Slow to Medium	Foliage, flowers
Slash Pine	Fast	Evergreen
Loblolly Pine	Fast	Evergreen
Live Oak	Medium	Evergreen, dependable
Water Oak	Medium to Fast	Relatively fast growth
Cedar Elm	Medium	Fall color, dependable

PLANT EVERGREEN TREES ON THE NORTH, NORTHEAST AND NORTHWEST. THEY WILL ALSO HELP BLOCK THE COLD WIND IN THE WINTER.

TREES AND LARGE SHRUBS ACT AS WIND BREAKS AGAINST COLD NORTHERS.



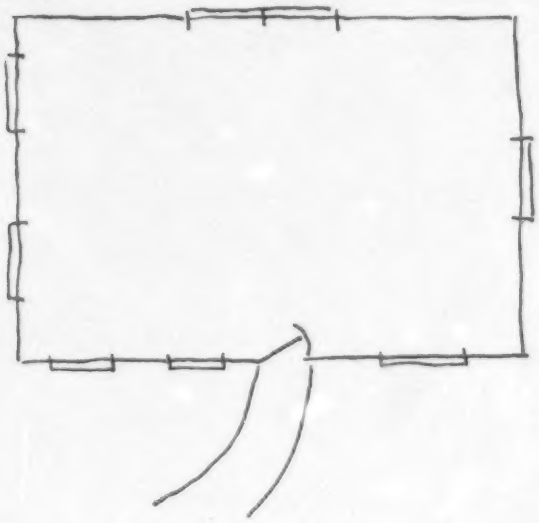
PORCH TRELLIS MAY BE PLANTED WITH DECIDUOUS VINE TO PROVIDE SHADED OUTDOOR AREA IN SUMMER AND SUNNY AREA IN WINTER.

LARGE DECIDUOUS TREES ON THE SOUTH, EAST AND WEST SHADE THE HOUSE FROM THE SUMMER SUN, DO NOT BLOCK THE WIND AND LET THE WINTER SUNSHINE IN.

LANDSCAPING DESIGNS

Draw trees and shrubs around these homes to illustrate energy conservation. Indicate North, South, East, and West directions.

1.



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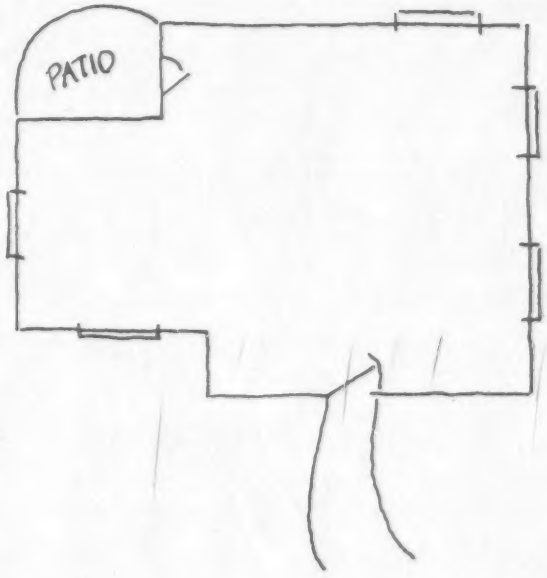

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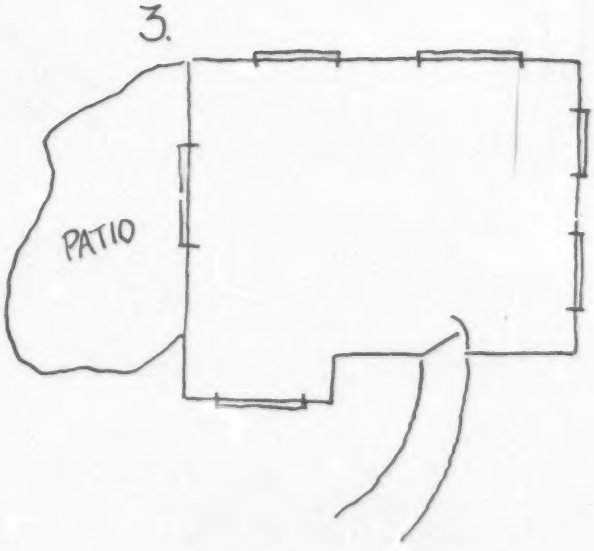

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HEATING AND COOLING ALTERNATIVES

I. Types of Heating Systems in Texas and Louisiana

A. Central Heating Systems - heated air is distributed through ducts to each room in the home.

1. Electric resistance - most common electric heating in this area.

2. Electric heat pump - during the cooling season the heat pump operates as a regular air conditioner, extracting excess heat from inside the house and transferring it to the outside. During the heating season, however, the heat pump reverses its cycle and begins to extract heat from the outside air and transfer it into the house.

3. Gas heat

B. Gas or electric space heaters

C. Panel-ray electric panels

D. Baseboard (not very common in this area)

E. Woodburning stove

F. Fireplaces - not very efficient unless it is a special type fireplace that has an outside air intake vent to the firebox.

G. Solar heating systems - not very common in this area due to the cost of installation and effectiveness of the system.

II. Cooling Systems

A. Central Cooling - cooled air is distributed through ducts to each room in the home.

1. Electric

2. Heat pump

3. Gas (absorption) - not very common.

B. Room air conditioners

C. Room unit heat pumps

D. Attic fans

E. Window or room fans

F. Ceiling fans

SELECTION OF ENERGY EFFICIENT EQUIPMENT E.E.R.'s OR S.E.E.R.'s

The big difference in air conditioners is how much they cost to operate. The difference is expressed as E.E.R., which stands for "Energy Efficiency Ratio." E.E.R.'s are to air conditioning what MPG's are to cars. The energy efficiency ratio is calculated by dividing the cooling capacity of an air conditioner (expressed in BTU's) by the number of watts it draws while running. So, instead of miles per gallon, you have BTU's per watt. Recently the U. S. Department of Energy modified E.E.R. terminology for central air system, so it is now known as "S.E.E.R.: or the "Seasonal energy efficiency ratio." S.E.E.R's are determined by a different testing procedure so a straightforward BTU/watt calculation cannot be used.

An S.E.E.R. of 8 or above is generally considered high-efficiency. The higher the S.E.E.R., the lower the operating costs and the higher the cost of the unit. For example, a 3-ton unit with an S.E.E.R. of 9 will cost about $495 a year to operate compared to about $687 per year for a similar unit with an S.E.E.R. of 6.5 - a savings of $192. In this area, most central air conditioning systems which are at the replacement stage have an E.E.R. of about 5.5. A minimum of 9 is recommended.

The size of an air conditioner may be expressed in tons or in B.T.U.'s. Multiply tons by 12,000 to convert tons to B.T.U.'s. If you are getting several estimates for a new air conditioner, be sure that you are comparing the same S.E.E.R.s and the same tonnage.

Ask your contractor for a copy of the S.E.E.R. fact sheet when comparing units. Room air conditioners are still measured in E.E.R.'s which are displayed on the EnergyGuide Label shwoing their relative efficiency.

SIZING UP YOUR A/C NEEDS

Air conditioners are like shoes - it's a disaster when you get them too small or too big. Just as all 5-foot-5 inch women don't wear the same size shoe, homes of the same square footage may not require the same size air conditioning model. By the same token, a house that required a 4-ton unit 10 years ago may not need a 4-ton unit today--depending on changes in insulation, weatherstripping and caulking, the growth of shading vegetation on the exterior, and family needs.

A too-small unit will run all the time and wear out early. A too-large unit will not only cost more to buy but will cycle too often and too briefly to remove the humidity effectively. Then you'll feel hotter and, consequently, turn down the thermostat to a cooler setting. Cooler settings and frequent cyclings lead to wear and tear and higher energy and maintenance costs.

The old rule of thumb - divide the square footage of the house by 400 to get the approximate tonnage of cooling needed - should never supplant a careful calculation of heat gain and loss for the specific house.

LOCATION OF AIR REGISTERS AND RETURNS

Locations of air registers and returns are important considerations, putting ceiling registers near, and with air flowing toward, the outside walls. This so-called perimeter system keeps outside walls and corners warm in winter and cool in summer, as opposed to locating air registers just inside room entrances.

MAINTENANCE

Besides changing filters at monthly intervals, other maintenance will be hosing off the outdoor coil once a year. If you don't want to call a professional, you can do this yourself. Simply turn off the electrical breaker; remove the grille that's held by four screws; hose off the coils form the inside out to remove dust between the fins. You should have your system checked annually for proper pressures.

COMPARATIVE SHOPPING

It is wise to shop around and compare prices to make sure you are getting the most energy-efficient equipment for your money.

Make sure that the dealer does quality work in equipment installation, including ductwork.

DUCTWORK

If your home has central cooling and/or heating, it will have ductwork. Ductwork is the air delivery system to the rooms. It is more commonly found in the attic or in the furred-down (low) areas of the ceiling.

Unless furred-down, the ductwork must have an insulation value of R-7 and be free of leaks. Otherwise you may be heating and cooling the attic area.

ELECTRIC ENERGY OPERATING COST

Cooling System	Typical Wattage	Period of Use	Cost/KWH (in cents) 5¢	6¢	7¢	8¢	9¢
Oscillating or Circulating Fan	88	1 hr.	-	1	1	1	1
Ceiling Fan	55	1 hr.	-	-	-	-	-
	100	1 hr.	1	1	1	1	1
Box or window fan	200	1 hr.	1	1	1	2	2
Whole House Fan (ventilator)	300	1 hr.	2	2	2	2	3
	500	1 hr.	3	3	4	4	5
Air Conditioner, Window							
5,800 Btu/hr. EER=8.7	665	1 hr.	3	4	5	5	6
12,800 Btu/hr. EER=8.7	1415	1 hr.	7	8	10	11	13
Air Conditioner, Central							
36,000 Btu/hr. SEER=.4	4300	1 hr.	22	26	30	34	39

-Less than ½¢ per use

We recommend that any of these methods be combined with proper landscaping, window treatments, caulking, weatherstripping, insulation and attic ventilation to money.

Sample Room Air Conditioner EER Calculation:*

$$EER = \frac{\text{Btu's/hour}}{\text{Watts}}$$

Example: $\frac{7000 \text{ Btu's/hour}}{870 \text{ watts}} = 8.0$ Energy Efficient Ratio

*Central units are measured by Seasonal Energy Efficiency Ratios (SEER). Computing the SEER requires measuring system capacity and amps drawn under different seasonal conditions. It cannot be computed with information off the units name plate. The dealer can provide this information based on the Department of Energy's approved tests.

CEILING FANS

Gulf States Utilities recommends that air conditioning thermostats be turned up to 78°F and heating thermostats be turned down to 65°F. How much can you save in energy and energy dollars by following these guidelines? How can you use the proper room circulator fan to give you comfort equivalent to the normal thermostat setting? What do you save after counting the energy used by the fan?

Air moving at 200 ft/minute velocity, approximately 2.3 M.P.H., feels 10° cooler to an active, lightly dressed person.* For less active persons, lightly dressed, it will feel abut 7° cooler. A 36" ceiling fan will distrubute air at a velocity of 200 ft/min. (avg.) in a room 12' x 12'. Likewise, a 52" fan will service a room 15' x 15' with the same average velocity.

In larger rooms, multiples of these fans are necessary to maintain the velocity of 200 ft./min. As rule, 36" fan should be used in breakfast areas, small bedrooms, bathrooms, small kitches, entry ways and alcoves. One or more of the 52" fans should be used in living rooms, large bedrooms, large family rooms and porches.

Each fan uses about 100 watts, or as much power as a 100 watt light bulb. These fans are so efficient that they can be run 8 hours a day for a little over 3¢; that's 90¢ a month or $10.80 a year.

Recommended locations for typical rooms are:

Homes with space heaters or oversized central heating units may benefit from ceiling for operation. Air temperature differentials can be as great as 1°F./ft. of ceiling height.

*Ref: ASHRAE HANDBOOK OF FUNDAMENTALS, 1972
Pg. 142.

ENERGY-SAVING IDEAS FOR HOME HEATING & COOLING

1. Lower the thermostat in the winter to 68°F and raise it in summer to 78°F.

   For every degree you raise the thermostat setting in the summer, you save 3% on the cooling part of the bill. Example: If you change the thermostat from 72°F to 78°F, this would equal 6°F X 3% = 18% saved on the cooling part of the bill. Two percent (2%) is saved for every degree the thermostat is lowered in winter.

2. Turn the central air conditioner up to about 85°F when leaving the house for long periods of time.

3. Change air filters once a month.

4. Turn off pilot light on gas furnace during summer months.

5. Dress appropriately for the recommended temperature settings.

6. Caulk and weatherstrip around windows, doors, attics, and crawl spaces to stop air leaks. Replace broken window panes.

7. In summer, keep blinds and draperies closed to retard heat gain. On sunny winter days, open them to add warmth.

8. Make sure home is properly insulated, including ductwork in the attic.

9. Seal ductwork leaks with duct tape.

KITCHEN PLANNING TIPS

Energy Choices

Gas ranges use energy less efficiently than electric ranges. For example, surface burners on gas ranges may be about 40% efficient, whereas surface units on electric ranges may be about 60% efficient.

Pilot lights use the most energy in cooking with a gas range. The heat produced by a pilot light in addition to the heat and moisture produced during the cooking process, requires the air conditioning system to run longer to keep the home comfortable. Recent studies indicate that a home using gas for cooking has a higher incidence of indoor air pollutants which could contribute to health problems.

The choice of energy source for cooking may be based on the efficient of use of the energy; however, it will more likely be based on other considerations such as whether gas is available, whether the kitchen is wired for an electric range, and whether gas or electricity is used for other purposes such as space heating and water heating.

Venting the Kitchen

A kitchen exhaust system is often desirable to vent smoke, moisture, and odors. A fan or a range hood uses energy to operate. In addition, if the fan or hood is vented to the outdoors, conditioned air (heated in winter, cooled in summer) is also vented along with the odors and smoke. Additional energy must be used to heat or cool replacement air. Therefore, use a fan or range hood sparingly.

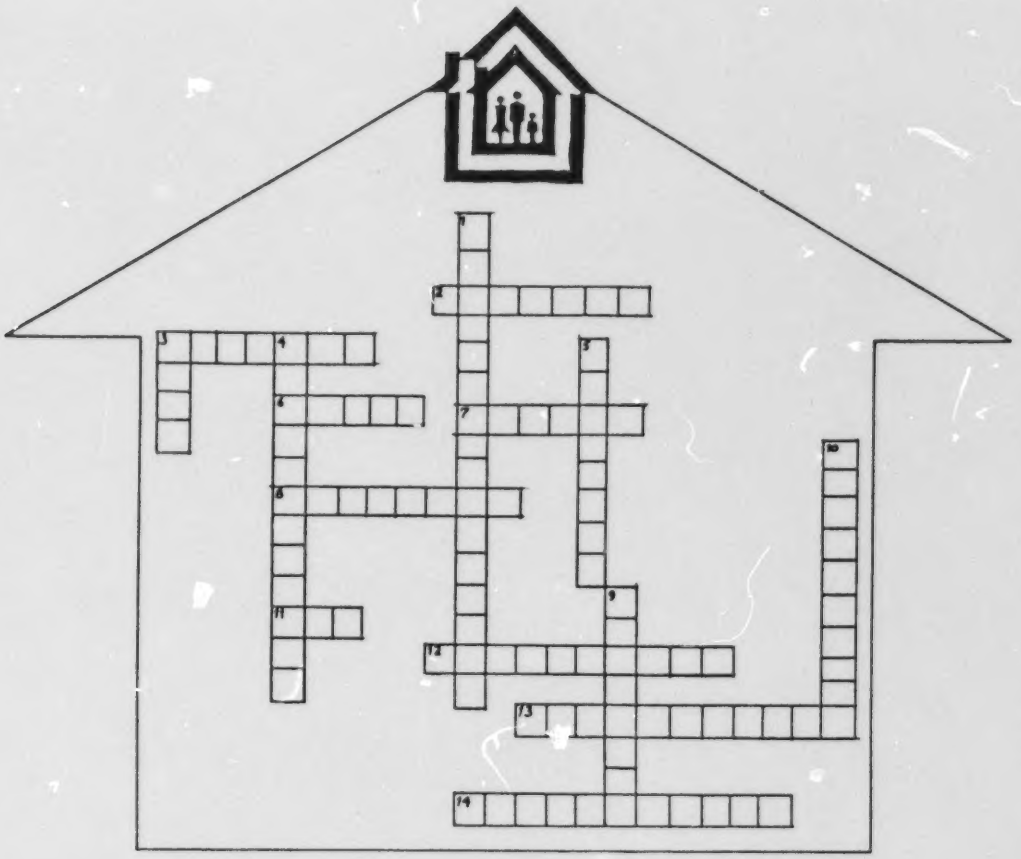
In summer, if the home is not air conditioned, the windows can be opened and used as a natural exhaust system.

In some systems, there is a damper. However, not all exhaust systems have

A built-in refrigerator or freezer may present a neat appearance; but unless the unit is designed to be built-in, restricted air circulation will cause the compressor to work overtime and use more energy. In addition to allowing for air circulation, the location of refrigerators and freezers should be away from

a damper. If there is no damper, a "flapper damper" can be purchased at minimal cost.

heat sources such as ranges, heat registers, and direct sunlight.

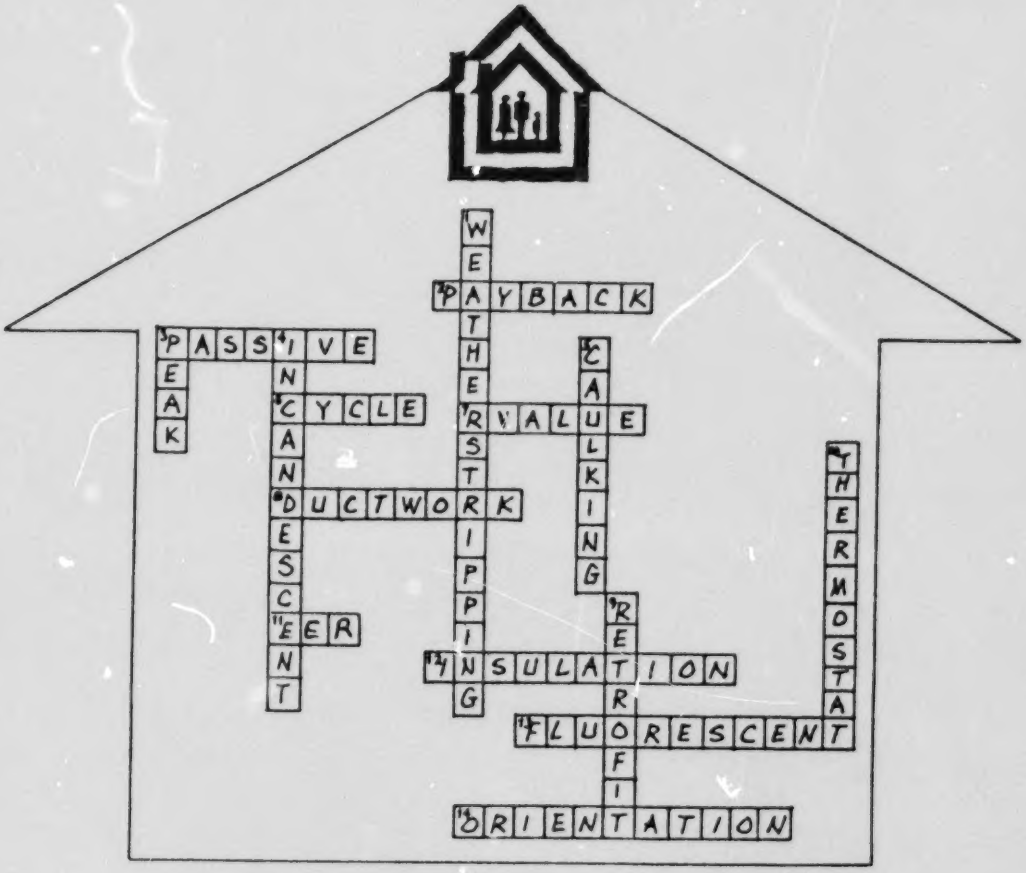


ACROSS

2. ____period-the amount of time it takes for an energy-saving improvement to pay for itself through savings on the utility bill.
3. ____solar systems collect the sun's energy more by design and orientation than with the use of hardware.
6. Life-____costs-total costs, including utility bills, of home or appliance for its useful life.
7. A measure of an insulating material's resistance to heat flow or transfer.
8. Air delivery system located in the attic, which should be wrapped in insulating material.
11. A rating used to help the consumer determine and compare the operating costs of air conditioning units.
12. Material used to prevent heat loss from a home in winter and heat gain in the summer.
13. The type of lighting which gives four times the amount of light as incandescents using the same amount of electricity.
14. Locating the house on a site in order to reduce heat gain on east and west so the home will be less expensive to cool in the summer.

DOWN

1. Material placed around doors and windows that keeps heat in or out of a home.
3. ____period-time of day when the greatest demand for electricity occurs, 2 to 6 p.m. Monday-Friday.
4. The type of lighting most commonly used in homes.
5. Flexible material used to fill up cracks where two immovable parts of the house meet, preventing air from entering and leaving the house.
9. To add energy-saving features to an existing home.
10. Lowering the ____ in the winter and raising it in the summer will save energy.



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NAME _____

COURSE _____

ENERGY CONSERVATION
(NERGYE SERCONTIONVA)

1. _____ (troingrefitt) - the process of improving energy efficiency in an existing home.

2. _____ (eatherizatwion) - protection from natural weather conditions to insure energy conservation.

3. _____ (sulintiona) - a heating & cooling barrier used in the attic, walls, and floors.

4. _____ (amfo ketgass) - an insulation used in wall receptacles

5. _____ (lkcauing) - a compound used to fill cracks at doors

6. _____ (pingwestripather) - comes ir metal, vinyl and rubber foam to fit in doors and windows.

7. _____ (terwa hateer : ketcaj) - fitted on a water heater for insulation.

8. _____ (ppie lainsution) - helps to keep water hot from the water heater to the faucet.

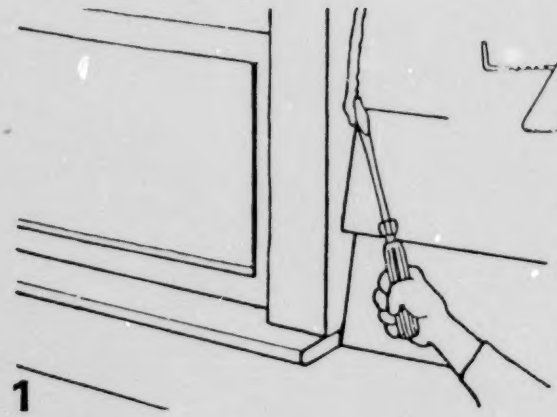
9. _____ (larso limf) - reducess heat gainas it reflects sun rays away from the windows.

10. _____ (larso creens) - a fiberglass covering with a special weave that aids in shading.

KEY

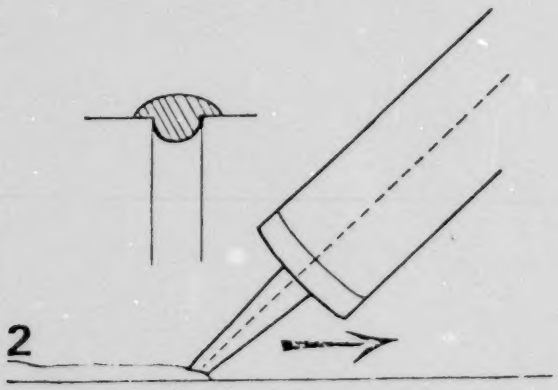
1. Retrofitting
2. Weatherization
3. Insulation
4. Foam gaskets
5. Caulking
6. Weatherstripping
7. Water heater jacket
8. Pipe insulation
9. Solar film
10. Solar screens

Caulking



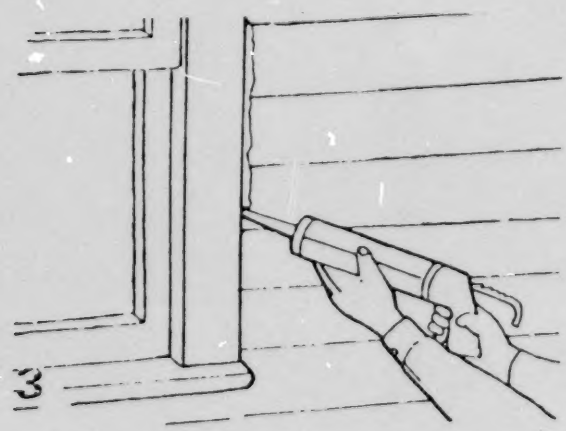
1

Before applying caulking compound, clean area of paint build-up, dirt, or deteriorated caulk with solvent and putty knife or large screwdriver.



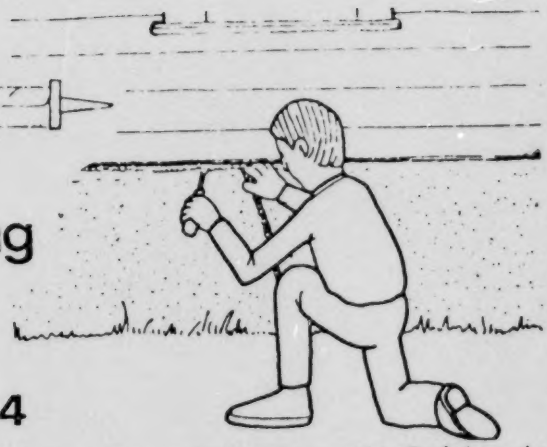
2

Drawing a good bead of caulk will take a little practice. First attempts may be a bit messy. Make sure the bead overlaps both sides for a tight seal.



3

A wide bead may be necessary to make sure caulk adheres to both sides.

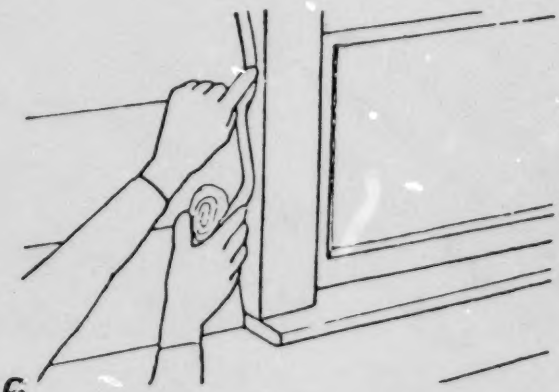


4

Fill extra wide cracks like those at the sills (where the house meets the foundation) with oakum, glass fiber insulation strips, etc.)

5

In places where you can't quite fill the gaps, finish the job with caulk.

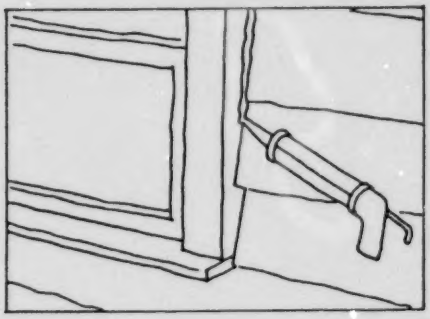


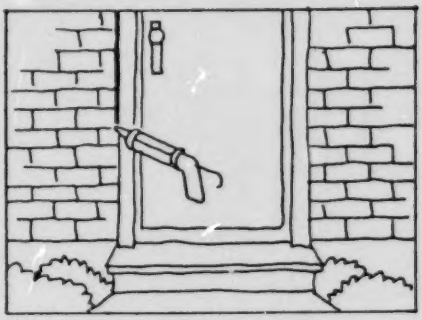
6

Caulking compound also comes in rope form. Unwind it and force it into cracks with your fingers. You can fill extra long cracks easily this way.

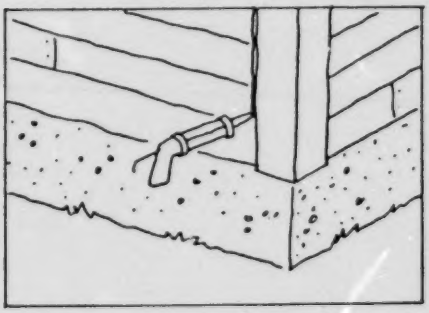
Installation:

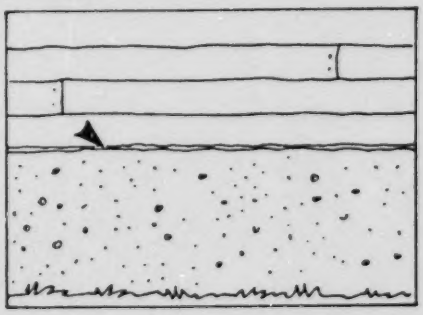
Caulking should be applied outside around window and door frames. . .

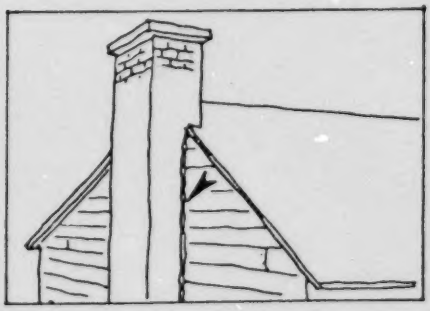


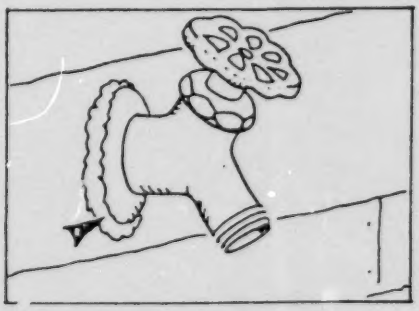


. . .and wherever else two different materials or parts of the house meet.

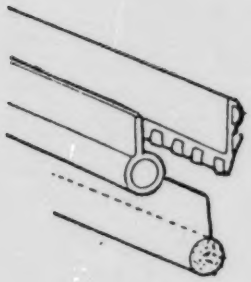
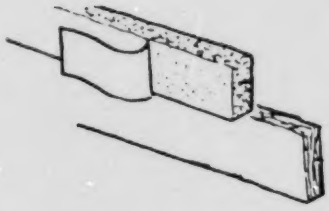
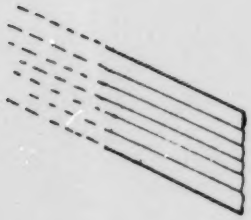






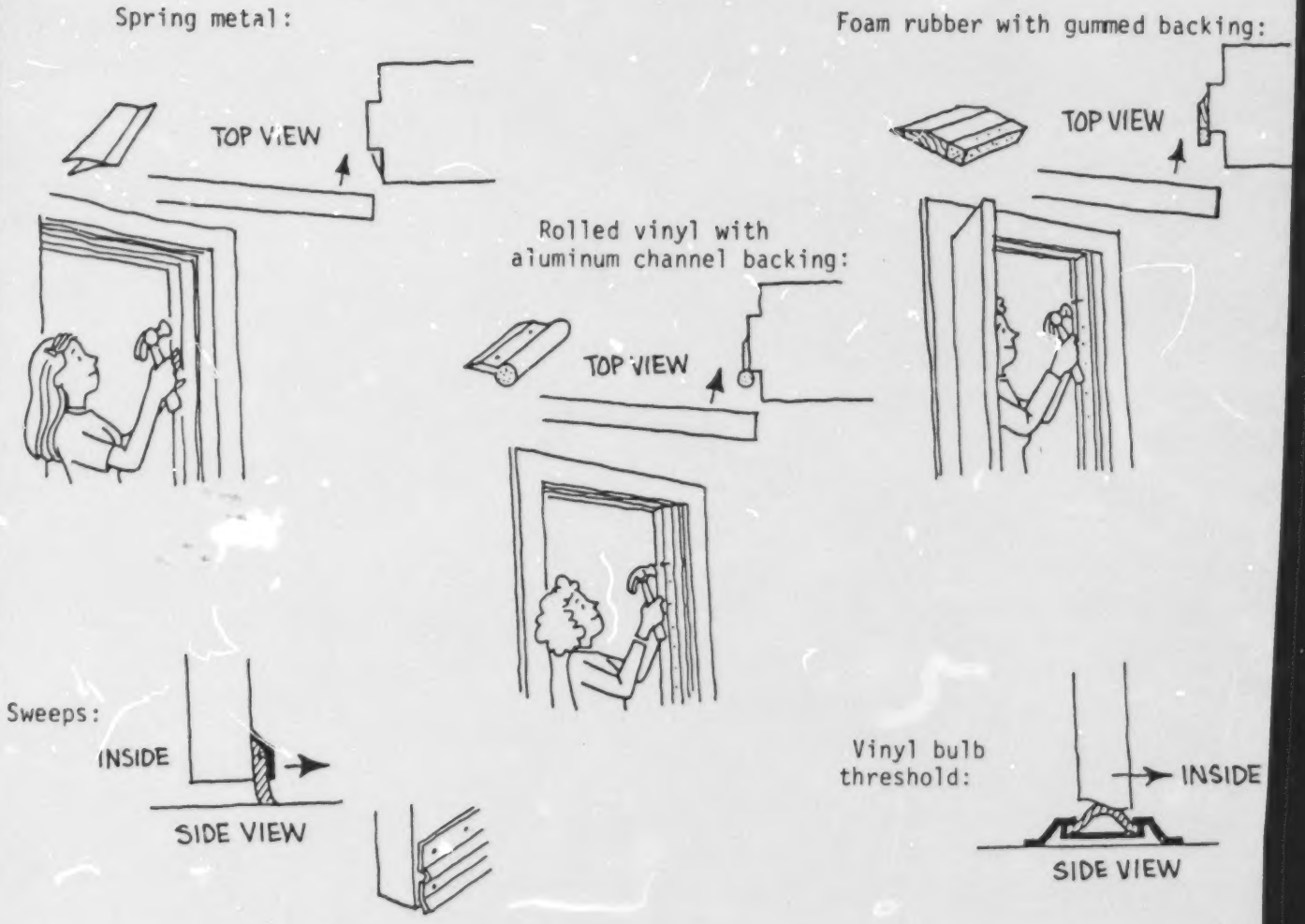


TYPES OF WEATHERSTRIPPING

TYPE		DURABILITY	COMMENTS
Rolled Vinyl with rigid Metal Backing		5 years	Must make complete contact for proper seal
Foam Rubber and Felt		1-2 years	Easy to apply. Short life span.
Thin Spring Metal		5 years and up	May lose some flexibility in time and therefore lose its sealing ability

Weatherstripping should be checked every year for its condition. If installed correctly the first time, it will be effective for years.

Look for other types of weatherstripping which may suit your needs such as interlocking thresholds, doorsweeps, etc.


Spring metal:
TOP VIEW
Foam rubber with gummed backing:
TOP VIEW
Rolled vinyl with
aluminum channel backing:
TOP VIEW
Sweeps:
INSIDE
SIDE VIEW
Vinyl bulb
threshold:
INSIDE
SIDE VIEW

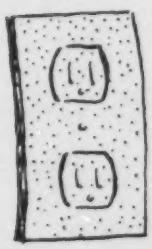
ADDITION OF GASKETS TO WALL RECEPTACLES AND SWITCH OUTLETS

DIRECTIONS

(Turn off power at breaker before removing plates)

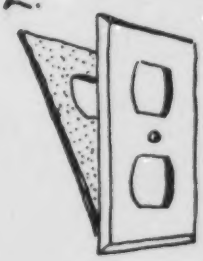
Place gaskets on all Wall Receptacles and Switch Outlets.

1.



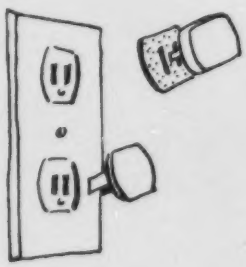
Punch out the 2 cap sealers (A) from Gaskets if not already removed. (Do not discard cap sealers.)

2.

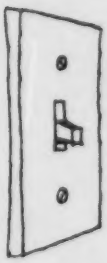


Remove Cover plate and place Gaskets behind cover plate. If Gasket is oversize, trim with scissors for a neat fit.

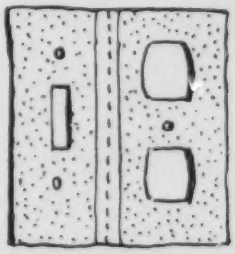
3.



Push plastic cap through the cap sealers (A) removed from Gasket and insert into the receptacles when not in use. (Various manufacturers' caps work with slight variation.)



For Light Switch Outlets, follow step No. 2 only.



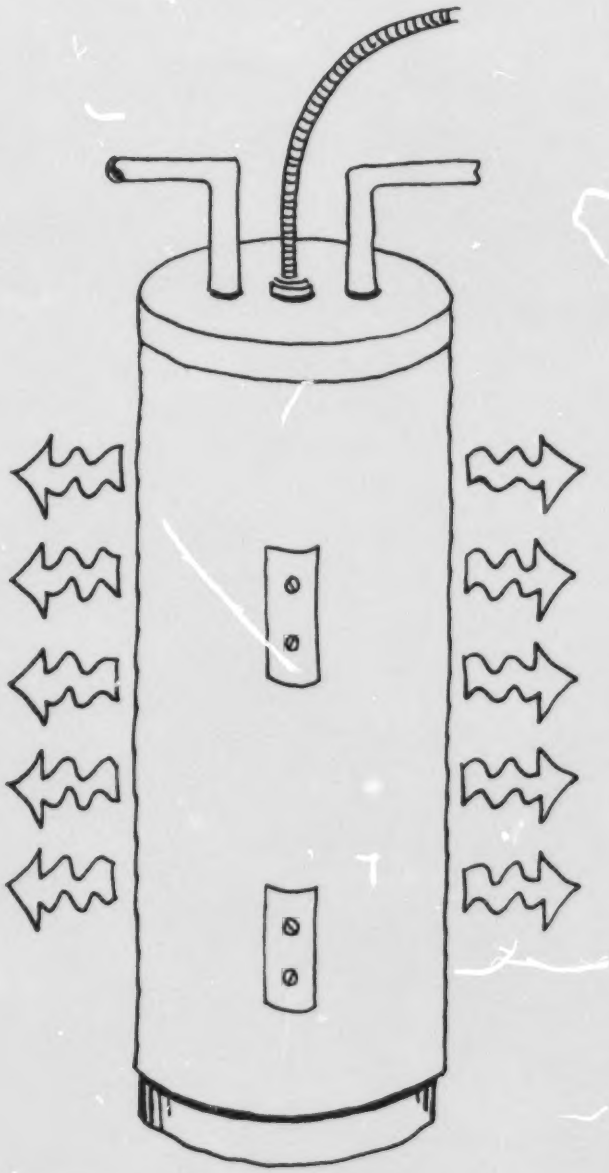
For Combination Outlets, lay the 2 different Gaskets side by side and line up opening with the cover plate. Trim to fit flush with each other and then tape together.

INSULATING WATER HEATERS

Your water heater loses heat through the tank (and vent pipe in gas water heaters). This heat loss is commonly referred to as **standby heat loss.** Think of what happens as you bring a pan of water to a boil and then turn off the heat. If you allow the pan of hot water to set for awhile, the hot water will eventually lose its heat to the air around it. The same thing happens to a water heater and hot water pipes. When is happens, your water heater has to work harder and more often to maintain its temperature setting.

Insulating your tank and pipes will help keep the heat where it belongs and will improve your water heater efficiency. Water heaters are built with some insulation around the tank. But, **you can save energy by adding another layer of insulation to the exterior surface of your water heater tank.** Keep in mind, if your water heater is a conservation model, chances are it is already adequately insulated. **If you have a gas water heater equipped with a vent damper, you should not add insulation to the tank, as this could lead to a safety hazard.**

You can buy and install a ready-made water heater insulation kit. The kit consists of a blanket of insulation and comes with "do-it-yourself" instructions. These kits are available at hardware stores, building supply stores and conservation centers.



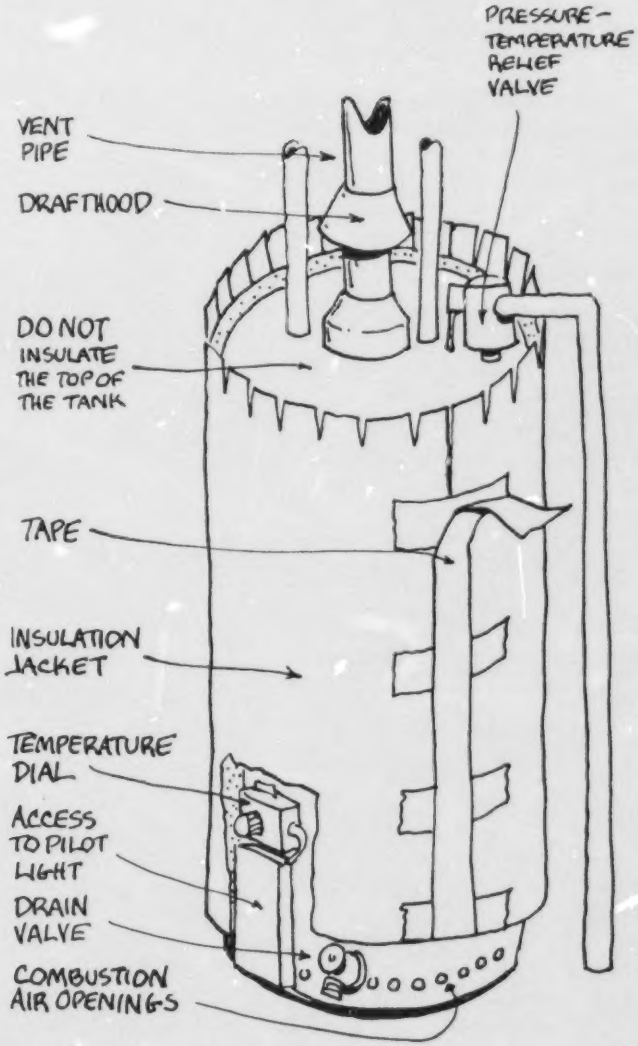
SOURCE: Water Heaters, Public Service of Colorado, Denver Colorado

INSULATING WATER HEATERS

Insulate your gas or electric water heater as shown in these illustrations. **Caution: Improper installation can cause serious safety problems.** It is very important to cut openings in the insulation to allow certain areas to breathe.

For **GAS** water heaters, you must **NOT** cover the following areas:

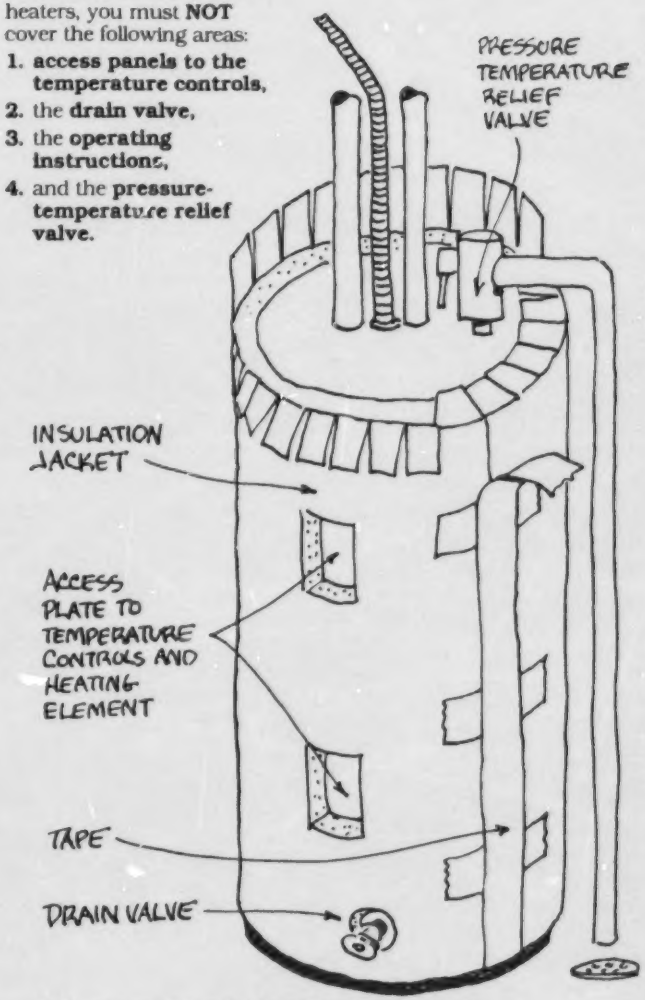
1. the **top of the tank,**
2. **below the drain,**
3. the **combustion air openings,**
4. the **pilot light access plate,**
6. the **drain valve,** and
7. the **pressure-temperature relief valve.**



GAS WATER HEATER

For **ELECTRIC** water heaters, you must **NOT** cover the following areas:

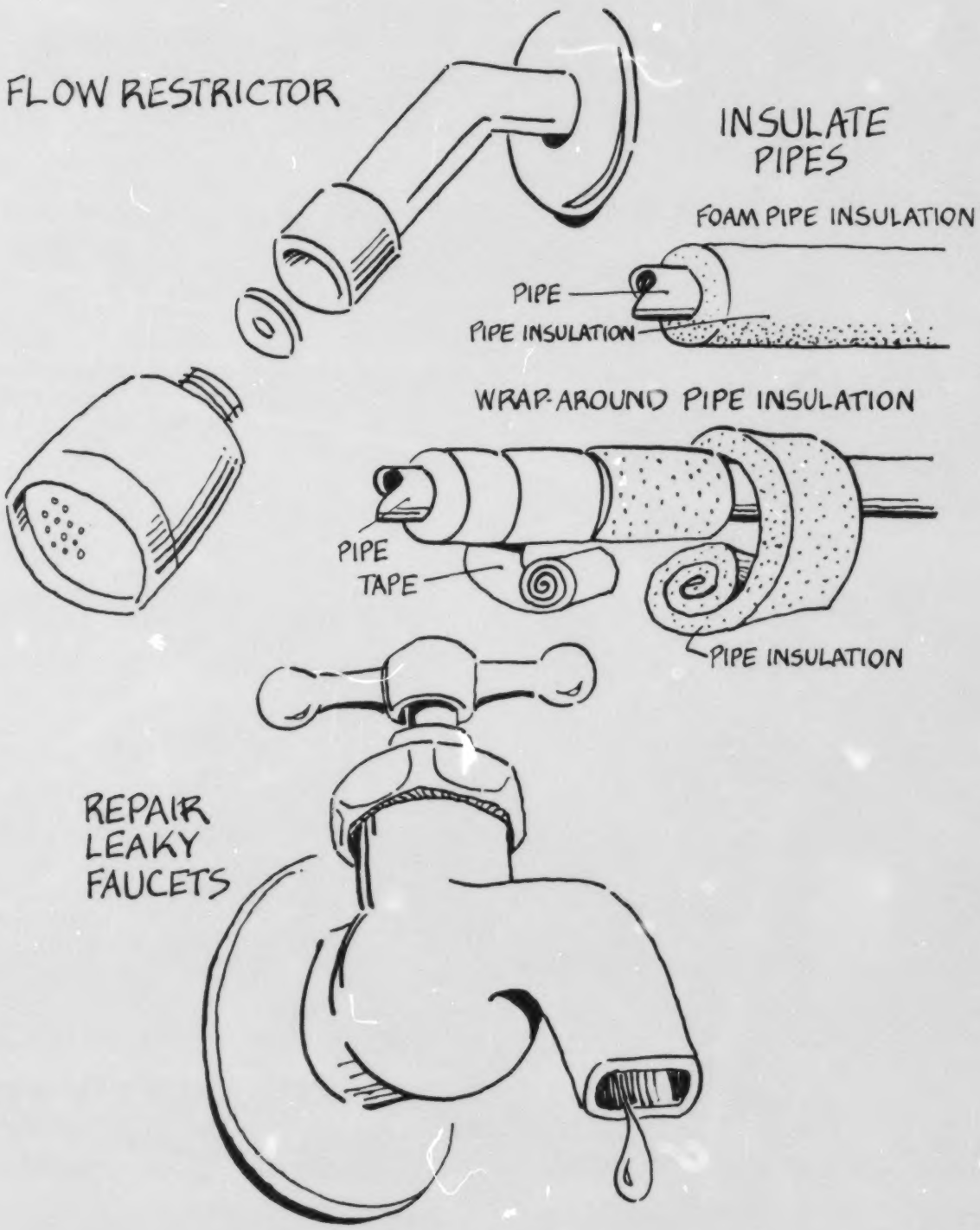
1. **access panels to the temperature controls,**
2. the **drain valve,**
3. the **operating instructions,**
4. and the **pressure-temperature relief valve.**



ELECTRIC WATER HEATER

SOURCE:
Water Heaters,
Public Service of Colorado,
Denver, Colorado.

WATER HEATING CONSERVATION MEASURES



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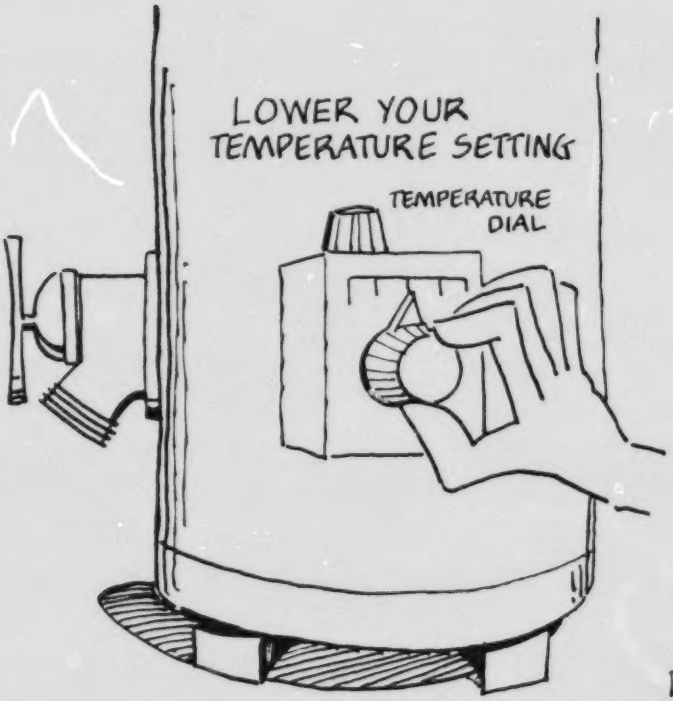
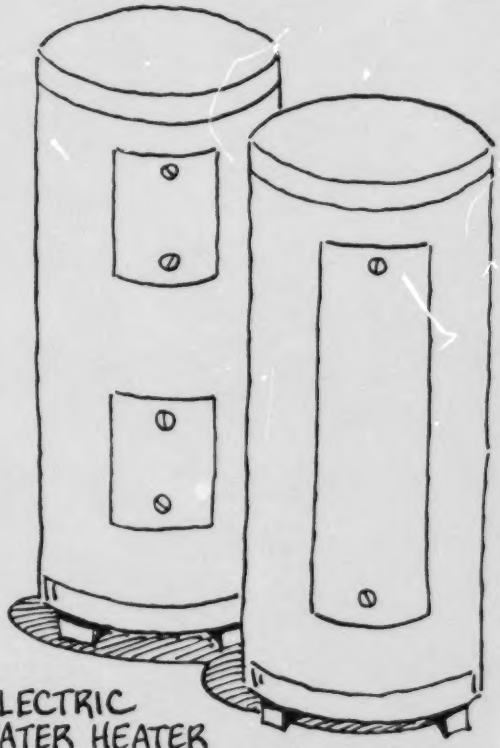
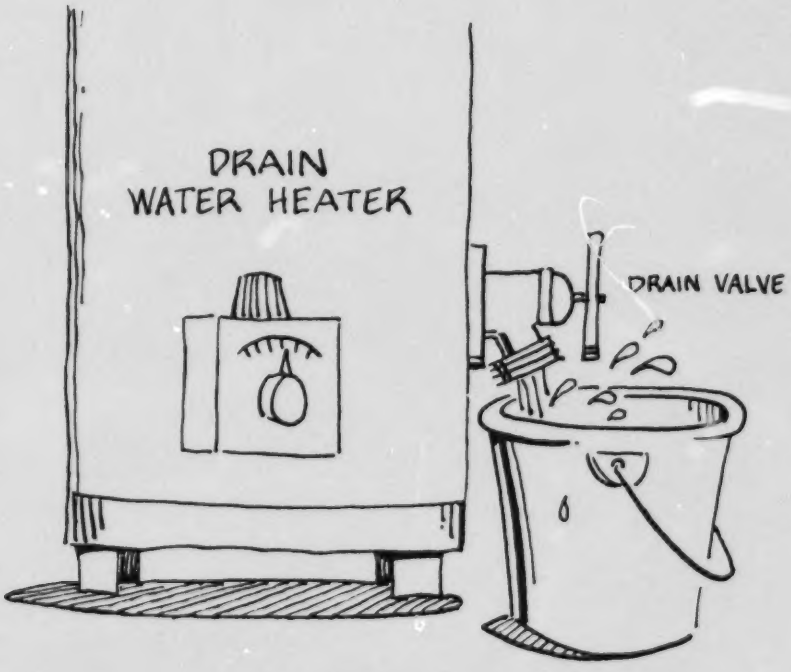
WATER HEATING CONSERVATION MEASURES







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SHOWER vs. BATH

If people took short showers instead of baths or lengthy showers, a lot of energy could be saved. It takes about an ounce of oil (or a cubic foot of gas, of ¼ kilowatt-hour of electricity) to heat a gallon of water.

Compare the water used for a bath and a shower. Fill your bathtub (at the temperature and depth you like best) and measure the depth with a yardstick (when you are out of the water). Record the depth: ____ inches. At your next bathing time, take a shower in the same tub. Keep the drain closed during your shower, but be careful not to overflow the tub. (Do not rush your shower; take your time!) This time, record your bathing time as well as the water depth.

Beginning Time _____ Ending Time _____

Duration of Shower _____ Water Depth _____

If you took a short shower, it should have required only about half as much as water as your bath.

Questions

1. What bathing practice is more conservative for you?

2. What would be the energy impact of taking a 20-minute shower?

3. What are some other ways to conserve energy while bathing?

Suggestions 1. If your shower was very lengthy you may need to measure the depth, empty the tub and then finish your shower and measure again. Add the two depths.

2. Investigate the water consumption used by other members of your family. Who is most conservative?

3. As a rough estimate of your water consumption you can use the formula for computing the volume, in gallons, of a tank: ____ height x ____ width x ____ depth ÷ 231 = ____ gallons.

HOT WATER AUDIT

The major uses of hot water in the home are for bathing and laundry. Use the data sheet provided to estimate your family's hot water consumption for a week.

Task	Number of Times/Wk.	Multiplier (in gallons)	Quantity of Hot Water (in gallons)
Laundry loads		15	
Tub baths		25	
Showers		20	
Dishwasher loads		10	
Washing dishes by hand		5	

TOTAL: _____

Tally the number of times per week the task using hot water occurs. Then multiply the number of times by the multiplier provided. The multiplier is the average amount of hot water required for the task. The resulting value is the quantity of hot water consumed for the task. Then add the quantities for each task to arrive at an estimate of the hot water your family uses in one week. (The average household uses about 350 gallons of hot water per week.)

You can now approximate the energy required to supply this quantity of hot water.

ELECTRIC WATER HEATER

_____ gallons X .25 kwh/gallon = ____kwh

If you use ____ gallons per week, you use approximately 52 times that per year, or ____ gallons.

Calculate the energy cost for a year's consumption:

____ gallons X .25 kwh/gallon = ____kwh

This is ____kwh for one year.

Find out the rate in your area for electricity per kwh and determine the cost of one year's hot water consumption.

_____kwh	X	_____cents	= $____
yearly energy consumption for hot water heater		rate kwh	

GAS WATER HEATER

____ gallons X 1.3 cu. ft./gallon = ____ cu. feet

If you use ____ gallons per week, you use approximately 52 times that per year, or ____ gallons.

Calculate the energy cost for a year's consumption:

____ gallons X 1.3 cu. ft./gallon = ____ cu. ft.

Find out the rate in your area for natural gas per ccf and determine the cost of one year's hot water consumption.

_____ mcf	X	_____	= $_____
yearly energy consumption for hot water		rate/ccf	

How could you save money and energy for hot water at your house?

Some things to look for if your hot water consumption is high:

1. Check your water heater's thermostat. It should be set at 120°F to 140°F or less.

2. Check for leaks.

3. Are the hot water pipes insulated?

4. Install flow restrictors and/or water saving shower heads.

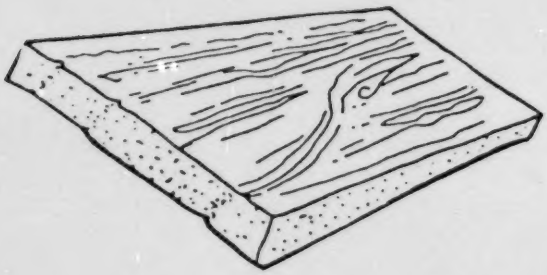
5. Does the water heater have an insulation blanket on it?

6. List ways your family might conserve hot water usage.

All of the figures and calculations in this activity are based on averages and estimates and do not indicate actual hot water use.

MAJOR TYPES OF INSULATION

RIGID BOARD



Made from polystryrene (extruded), expanded urethane (preformed), glass fiber, polystyrene (molded beads).

Where Used

- exterior wall sheathing
- floor slab perimeter

LOOSE FILL

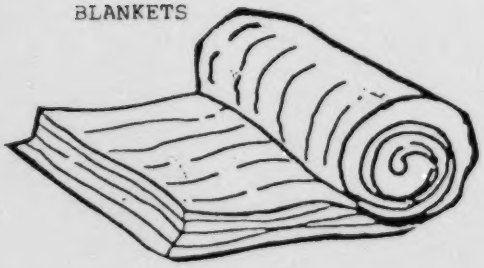
Made from glass fiber, mineral wool or cellulose.

May be blown in or poured in.

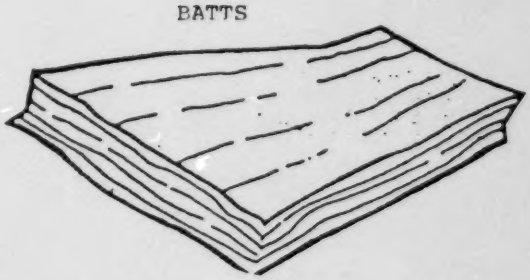
Where Used

- attic floor
- blown in walls or existing homes

BLANKETS



BATTS



Made from glass fiber or mineral wool. Precut to fit specific areas.

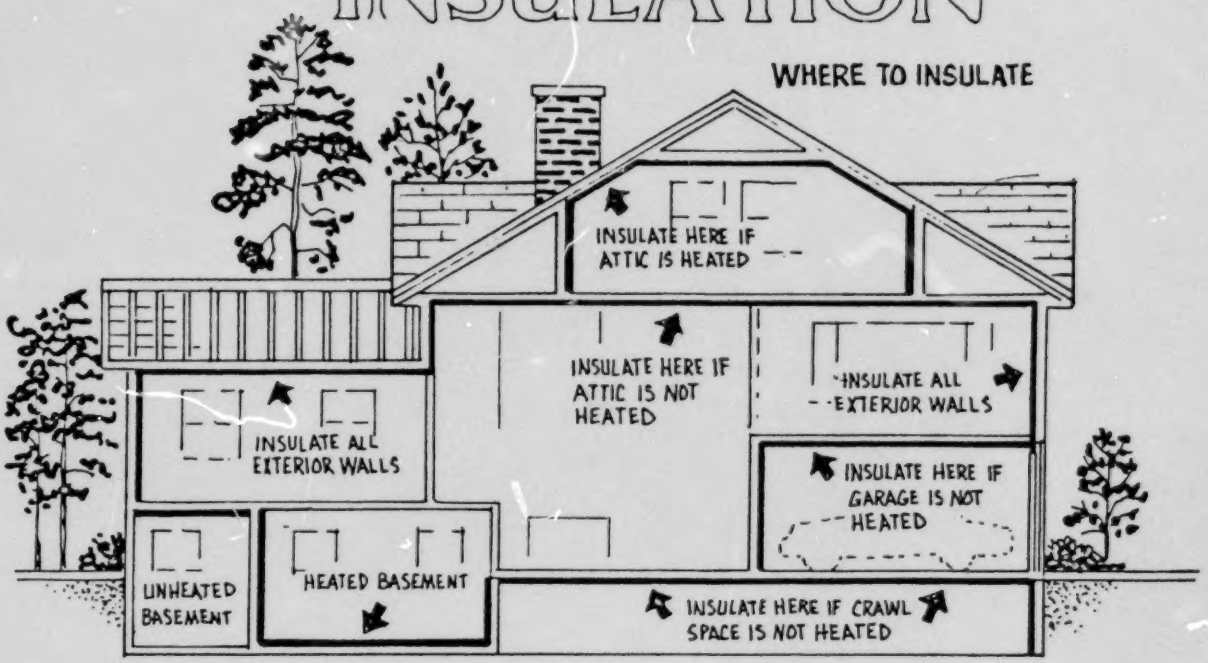
Where Used

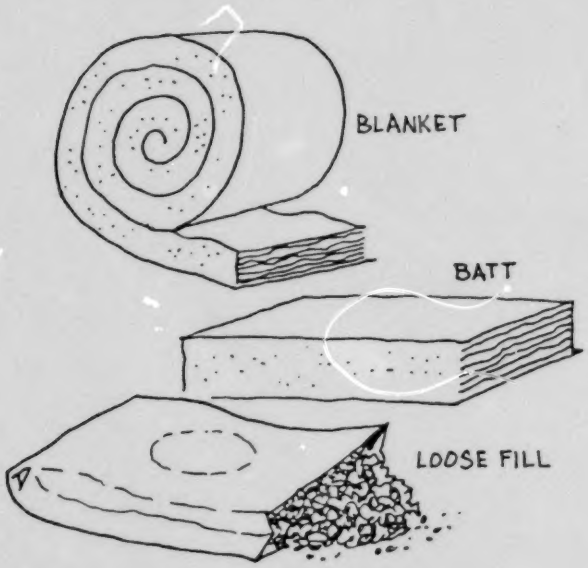
- attic floor
- exterior walls

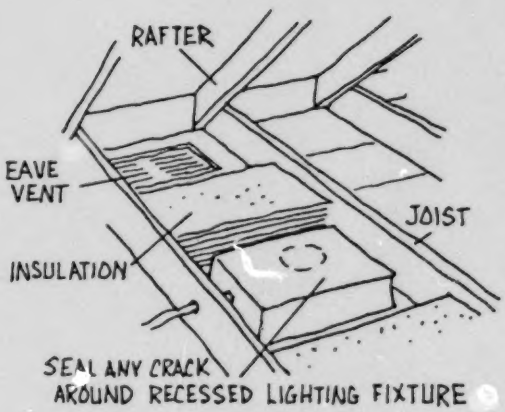
Where Used

- attic rafters (cathedral ceiling)
- underside of floor over crawlspace

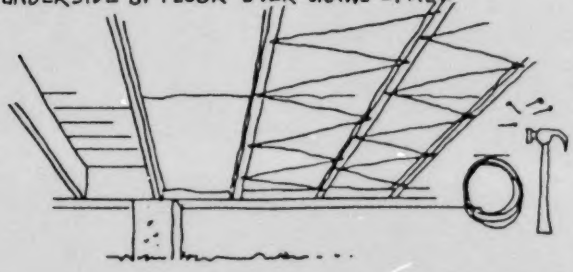
INSULATION


WHERE TO INSULATE
INSULATE HERE IF ATTIC IS HEATED
INSULATE HERE IF ATTIC IS NOT HEATED
INSULATE ALL EXTERIOR WALLS
INSULATE ALL EXTERIOR WALLS
INSULATE HERE IF GARAGE IS NOT HEATED
UNHEATED BASEMENT
HEATED BASEMENT
INSULATE HERE IF CRAWL SPACE IS NOT HEATED





UNDERSIDE OF FLOOR OVER CRAWL SPACE



How Thick Your Insulation Should Be:

The R-Value, or Resistance Value, of insulation measures how well a material retards the flow of heat in or out of a building — the higher the R-Value, the more effective the thermal protection.

Always specify insulation on the basis of the desired R-Value and **not** in "inches," since different materials have different R-Values per inch of thickness.

Suggested R-Values for insulation installed in this climate area are as follows:

	Recommended Levels	**Minimum Levels**
ceilings and attics	R-26 to R-30	R-19
floors over garage, porch or open crawl space	R-19	R-11
enclosed crawl space	R-11	R-11
exterior walls	R-13 to R-18	R-11
perimeter of concrete slab on grade	R-7	R-0

TYPE OF INSULATION

	BATTS OR BLANKETS		LOOSE FILL (POURED-IN)			
	glass fiber	rock wool	glass fiber	rock wool	cellulosic fiber	
R-11	3½"-4"	3"	5"	4"	3"	R-11
R-19	6"-6½"	5¼"	8"-9"	6"-7"	5"	R-19
R-22	6½"	6"	10"	7"-8"	6"	R-22
R-30	9½"-10½"*	9"*	13"-14"	10"-11"	8"	R-30
R-38	12"-13"*	10½"*	17"-18"	13"-14"	10"-11"	R-38

*two batts or blankets required.

IN THE BANK...OR UP THE CHIMNEY

MAKE A CONTAINER THAT WILL KEEP AN ICE CUBE FROM MELTING

MATERIALS: Ice cubes, ziplock bags, foil, strips of newspaper, string, styrofoam pieces, wood, saran wrap, metal cans, glass jars, fabric remnants, styrofoam cups.

GOAL: To prevent, for the longest time possible, the ice cube from melting.

PROCEDURE: Divide students into teams. Select materials for insulating their ice cube.

Place ice cube in ziploc bags to retain melted water. Next, build container for insulating ice cube. Encourage teams to choose different materials and means of construction, such as thickness of wrapping. In order to keep trace of the melting process, place one ice cube in a plastic bag and place in an area where it will be visible to the students. It will take about 1 3/4 hours for a typical ice cube from a refrigerator tray to melt; however, this activity could be done during one class period. Start experiment at the beginning of the class period.

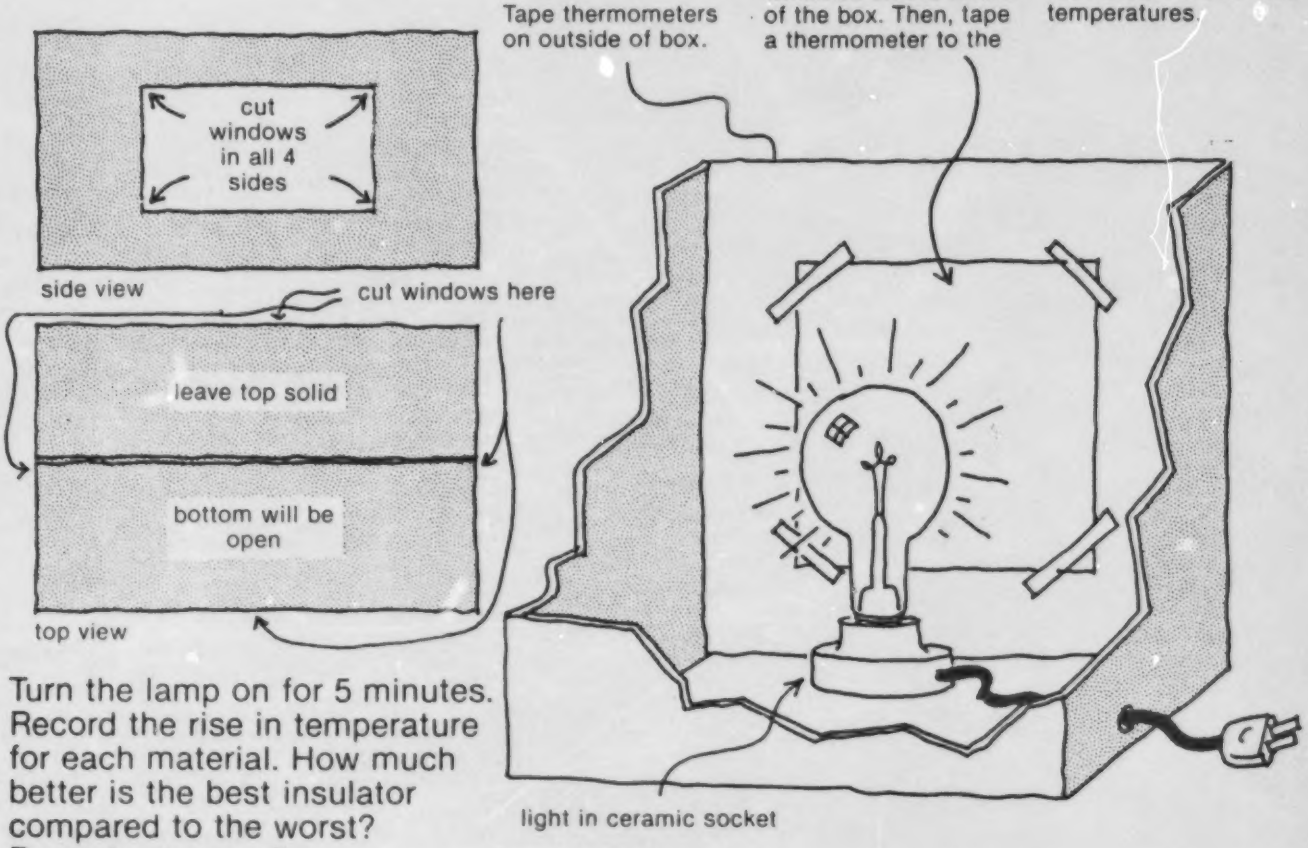
When the ice cube suspended in the plastic bag is melted or nearly melted, have students obtain the ice cube bags from their environments and compare the results. Identify with students the materials that preserved the ice cube the longest. Did the thickness of the material make any difference? Ask them to think about what materials they would use if they performed the experiment again.

WHAT'S THE BEST INSULATOR?

MATERIALS:

100 Watt bulb in ceramic socket — see drawing
A variety of insulating and non-insulating materials such as wood, aluminum foil, fiberglass (3″ or 4″), glass, metal, newspaper, heavy cloth, etc.
4 Thermometers, cardboard box, watch
Masking tape

Set up the box like this:


cut windows in all 4 sides
side view
cut windows here
leave top solid
bottom will be open
top view
Place the light in the center of the box.
Tape thermometers on outside of box.
Tape 4 insulating materials over the windows on the *inside* of the box. Then, tape a thermometer to the *outside* of the each insulating material and record before and after temperatures.
light in ceramic socket

Turn the lamp on for 5 minutes. Record the rise in temperature for each material. How much better is the best insulator compared to the worst? Record your results.

THE GREAT HOT TEA RACE

CHALLENGE: Find out which material is the best insulator.

TOOLS:
Five half-pint size jars and lids
Enough tea to make ten cups
Water for the mix
Measuring cup
Hot plate for heating water
Thermometers
Fiberglass insulation, batt type
Newspaper
Heavy cloth
Aluminum foil

TASK:

1. Make ten cups of tea and heat it.

2. Wrap one jar with fiberglass, one in newspaper, one with heavy cloth, one in aluminum foil, and leave one jar without a wrap, making sure the bottom is covered.

3. Fill each jar with 100 ml of tea.

4. Record the temperature of each jar.

5. Put lids on each container.

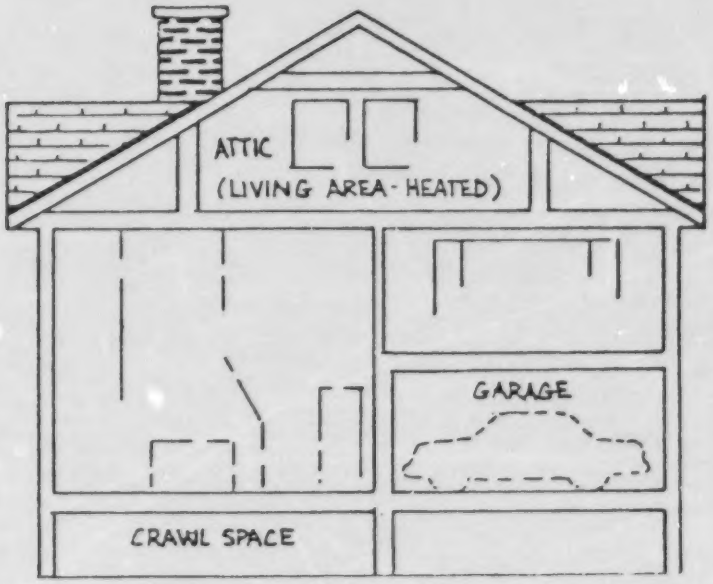
After 10 minutes, remove the wraps, open them and check the temperatures. Record the temperature here:

Container	Temperature		Temperature Difference
	Before	After	
Fiberglass			
Newspaper			
Heavy Cloth			
Aluminum foil			
No wrap			

NOTE: Hot chocolate may be used instead of tea.

ACTIVITY SHEET
Insulation

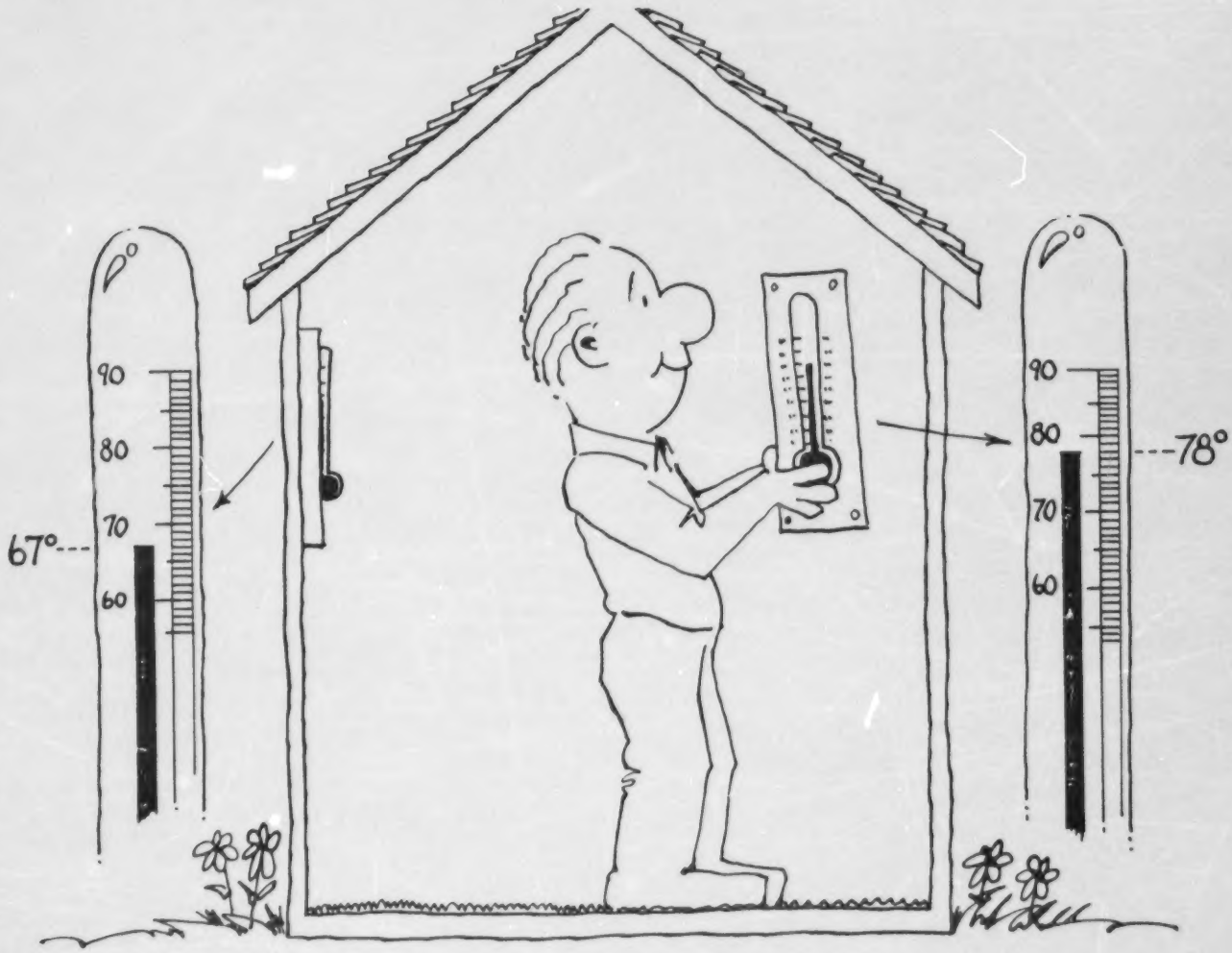
Directions: Shade in the areas where insulation is needed.



Now, with the help of your parents, check these places in your home for insulation.

Wall Insulation

During the heating or cooling season, when the heating or cooling equipment is operating, place a thermometer firmly against the inside surface of an exterior wall and another in the center of the room. It's easiest to hang the thermometer on a picture nail or hook on the wall and place it in a chair in the middle of the room. Allow sufficient time for the temperatures to register and then record the two readings. If the difference between the two readings is greater than 5°F, the wall is probably not adequately insulated. The example illustrated on the next page shows an exterior wall temperature of 67°F and a center of the room temperature of 78°F.



The next step is to determine the difference in the two readings: 78°F - 67°F = 11°F. The difference is greater than 5°F, therefore, for this example, we would draw the conclusion that the wall may be inadequately insulated.

Now you try this exercise at your house. You may wish to try it in several rooms with exterior walls.

Room _____.

Outside wall thermometer reading _____

Center of the room thermometer reading _____

The difference between the readings:

_____ - _____ = _____
(higher reading) (lower reading) (difference)

Is the difference greater than 5°F? _____

Conclusions:

Are there reasons other than inadequate wall insulation which might cause a difference in the temperature readings? _____ What might they be? _____

Another way to check for wall insulation is to remove an electrical outlet cover on an exterior wall, AFTER TURNING OFF THE ELECTRICITY TO THE OUTLET. Then, take a flashlight and look into the wall for insulation.

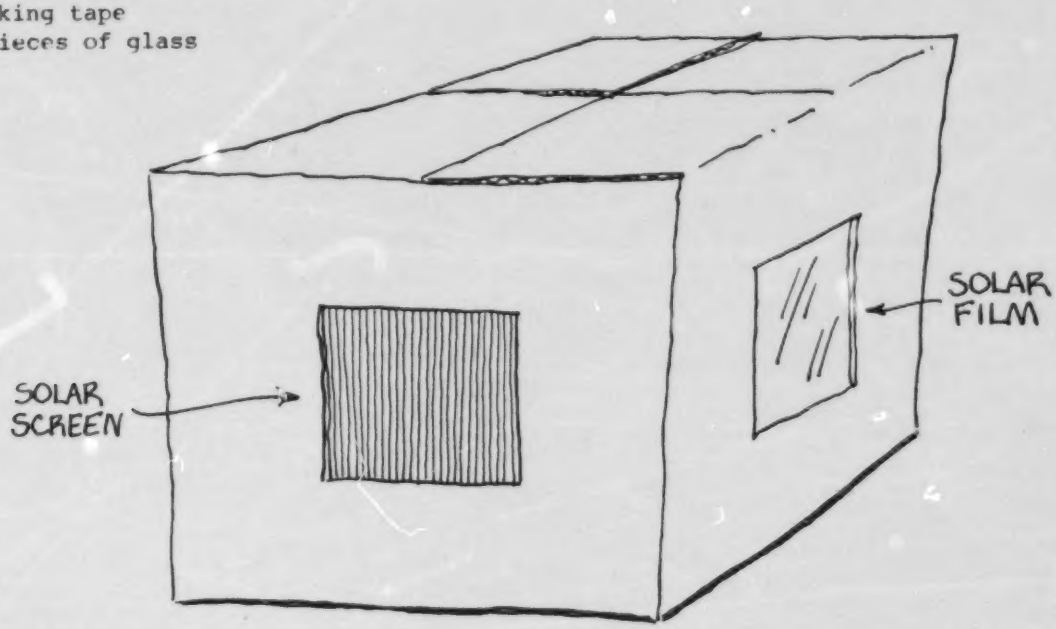
Attic Insulation & Floor Insulation

Go up into the attic or look under your home for insulation in these areas.

SOLAR FILM/SOLAR SCREEN EXPERIMENT

MATERIALS:

Medium size box
100 watt light bulb and light socket
Pieces of solar screen, solar film, and clear glass
4 thermometers
Timer or watch
Masking tape
3 pieces of glass



1. Cut window openings in 3 sides of the box. Leave the top solid. Bottom will be the open side. Place a piece of glass over each window opening.

2. Cut a small hole in one end of the box for the cord from the light socket to get to the outlet.

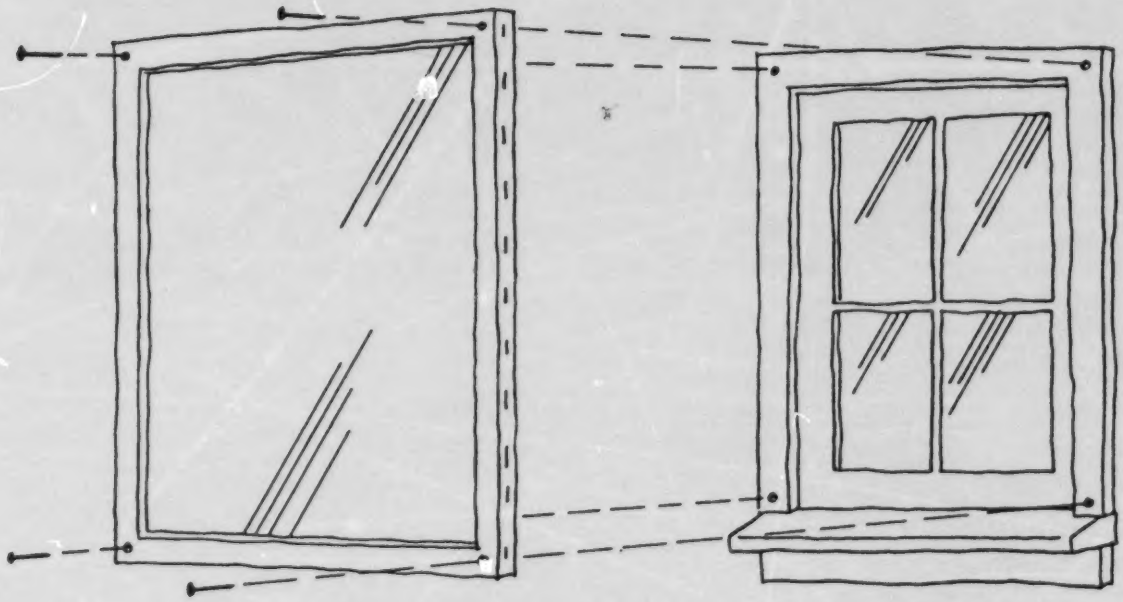
3. Cover the one window with solar screen, one with solar film, by taping the materials to the box. Leave one window unshaded.

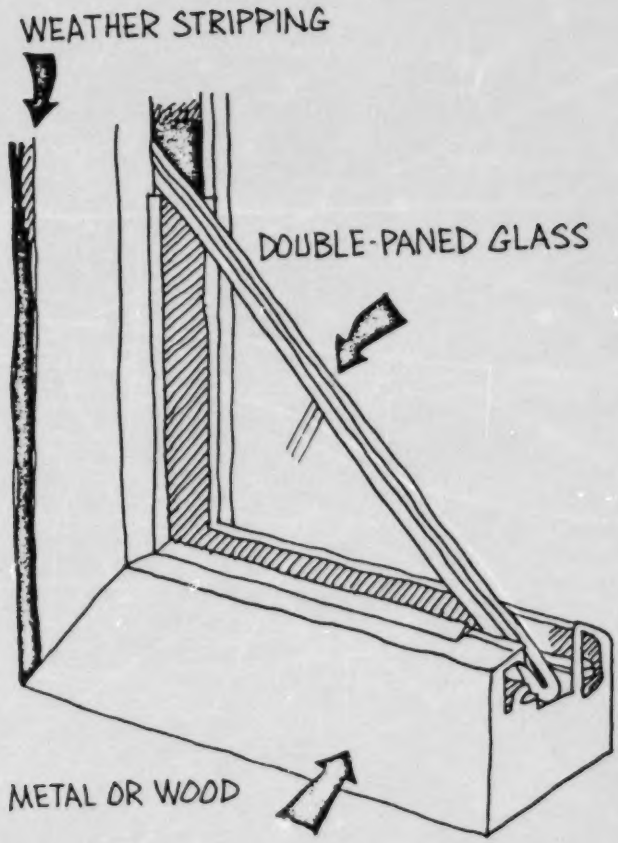
4. Next, tape the thermometer to the outside of each material.

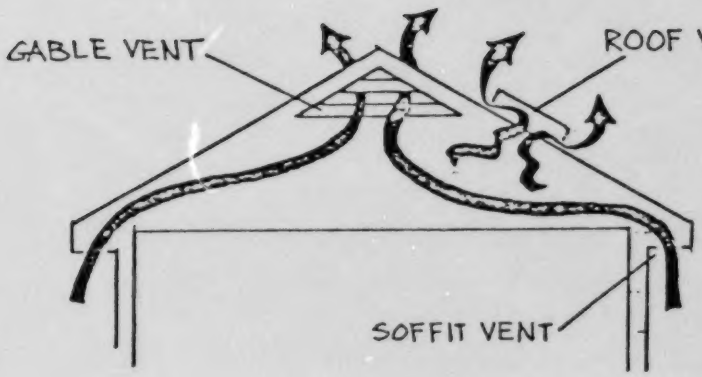
5. Place the light in the center of the box.

6. Turn the lamp on the for 5 minutes. Record the rise in temperature for each material.

7. Compare the temperature at the end of 5 minutes. What is the purpose of solar film and solar screen? How could these materials help save energy at home?

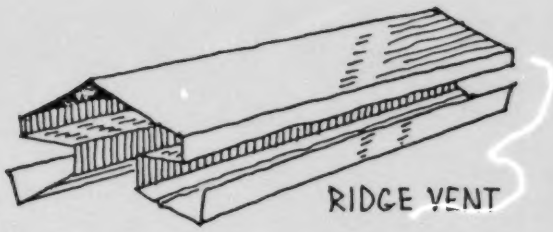



WEATHER STRIPPING
DOUBLE-PANED GLASS
METAL OR WOOD

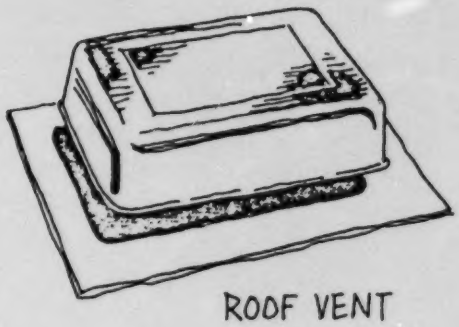


ATTIC VENTILATION HELPS LOWER SUMMER TEMPERATURES. ALSO ALLOWS MOISTURE VAPOR TO ESCAPE IN WINTER· MINIMIZING CHANCE FOR CONDENSATION.

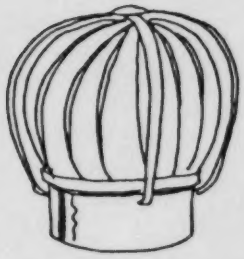
ATTIC VENTILATION



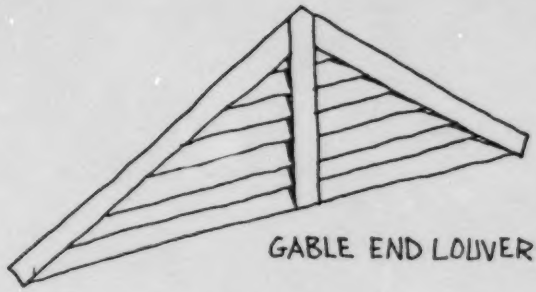
RIDGE VENT



ROOF VENT



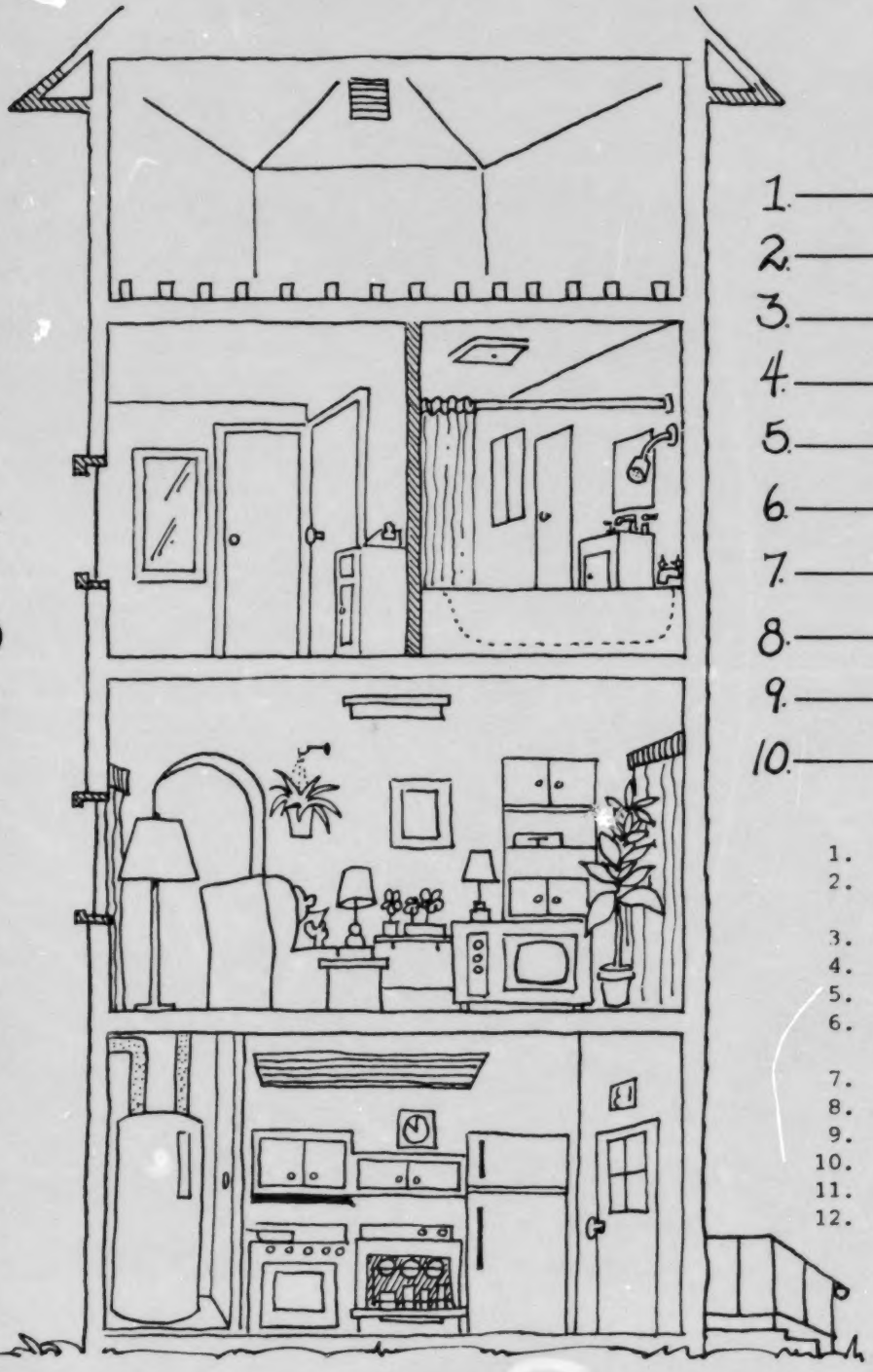
ROTATING TURBINE



GABLE END LOUVERS

DECISIONS TO WEATHERIZE

INSTRUCTIONS: Locate the areas of this house that could be weatherized to improve energy efficiency. List at least ten (10) of these areas.



1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Possible Answers

1. Weatherstrip doors
2. Install foam gaskets behind wall outlets
3. Caulk windows
4. Insulate walls
5. Insulate attic
6. Shade windows on east and west sides of home
7. Insulate hot water pipes
8. Apply water heater jacket
9. Install ceiling fans
10. Install attic ventilation
11. Install storm windows
12. Install shower flow restrictor

NAME _____

COURSE _____

ENERGY CHECKLIST

OBJECTIVE: To provide an easy and quick scan of the home to reveal possible sources of energy waste.

HOUSE: THE SHELL	YES	NO
1. Are plants located around the house to block unwanted sun?		
2. Are drapes and furniture located so they do not obstruct heating, air conditioning or ventilation?		
3. Are cool colors used in the interior of the house to achieve a cool setting?		
4. Do warm colors dominate in the hotter rooms of the house?		
5. Do the interior textures reflect a warmer setting?		
6. Are the interior furnishings smooth and sleek to achieve a cooler atmosphere?		
7. Are the interior furnishings plush and cozy to create a warm setting?		
8. Is the outside exterior finished to reflect sunlight and heat?		
9. Are the windows and doors caulked and weatherstripped?		
10. Are the wall receptacles backed with foam gaskets?		
11. Is the attic well insulated?		
12. Are the walls insulated?		
13. Is the hot water heater fitted with a jacket?		
14. Are hot water pipes wrapped?		
15. Are the windows protected with solar screen, solar film or other shade?		
16. Is the thermostat set at 68°F or below during the heating season?		
17. Is the thermostat set at 78°F or above during the cooling season?		

Name:

Course:

Period:

School:

Type Home:
____One-story ____Two-story
____Mobile home
1975 or older ____1976-present ____
____Apartment Upstairs____Downstairs____
____Townhouse
____Estimated square feet of home

HOME ENERGY CHECK

Most families pay higher than necessary utility bills because their house does not use energy efficiently. With this checklist, you will discover where your home is wasting fuel and what simple improvements can help reduce your family's utility bill. This check will take about 60 minutes but it will pay off with noticeable savings. Get these tools together to do your check: flashlight, ruler, pencil, and screwdriver.

If your home scores below the minimum points for each section, your home is an energy-waster in that area.

Circle the correct answer and place points in the last column.

INSULATION			Yes	No	Pts.
1. Ask your parents to check the attic insulation.					
a. What does the insulation look like?					
Loose particles	None				
Batts/blankets	Unknown				
b. What color is the insulation?					
Dark gray-brown (mineral wool)					
Pink or yellow (fiberglass)					
Light gray (cellulose)					
2. The R-Value (resistance to heat flow)		R-26-30	18		_____
(Use ruler to measure depth between		R-22-25	16		_____
ceiling joists and then use formula		R-19-21	14		_____
below.)		R-13-18	7		_____
		less than R-13	0		_____

NOTE: If you live in an apartment, ask your parents how much insulation is estimated to be in the attic. Consider the downstairs apartment to have the same amount of insulation as the upstairs apartment. If you live in a mobile home constructed before 1976, the R-Value is less than 13; constructed in 1976 or after, the average R-Value is 14.

FORMULA:

Example:	3R's x 6 inches = R-18
Rockwool:	
Loosefill:	3R's x ____ inches = R-____
Blankets:	4R's x ____ inches = R-____
Fiberglass:	
Loosefill:	2R's x ____ inches = R-____
Blankets:	3R's x ____ inches = R-____
Cellulose:	
Loosefill:	4R's x ____ inches = R-____

	Yes	No	Pts.
3. Are walls insulated? Ask your parents to see if walls are insulated. The Department of Energy recommends the following: TURN OFF THE ELECTRICITY AT THE BREAKER BOX. Remove the plate covers from the electrical outlet on an outside wall. Shine a flashlight into the space between the receptacle box and the wall material and see if there is any insulation. Note, however, that in some homes with existing wall insulation, the insulation is not installed immediately adjacent to the receptacle box. (Mobile homes constructed before 1976 may be considered as having no wall insulation.)	7	0	____
4. Is the house on a slab foundation or is the house on piers with insulation attached underneath the flooring?...or...	7	0	____
5. Is the house on piers with the crawl space enclosed?	3	0	
SUB TOTAL (1-5)			____
Maximum Pts. - 35			____
Minimum Pts. - 17			____

VENTILATION

6. Is the attic adequately ventilated? (A rule of thumb is one eave vent for every 4 ft. of roof eaves and 1 roof vent for every 600 sq. ft. of attic ventilation or two gables.) Ventilation reduces buildup of moisture in winter and of heat in summer. This minimizes temperature transfer into the living area and allows insulation to work better.	3	0	____

WINDOWS

7. How many windows does this house have? _____

North_____ East_____
South_____ West_____

8a. Are the windows on the west side of the home shaded by trees, awnings, porch cover, shutters, solar screen, solar film, etc? (Distribute points to your judgement. If half the windows on the west are unshaded, give 3 points.)	6	0	____

	Yes	No	Pts.
8b. Are the windows on the east shaded? (Distribute points same as 8a.)	6	0	____

NOTE: Drapes or blinds do not count. Look for a shading device on the outside of the house or applied to the window (solar film).

SUB TOTAL (6,7,&8) ____
Maximum Pts. - 15
Minimum Pts. - 10 ____

AIR LEAKAGE

9. Are all windows weatherstripped and caulked? Check around window and frame. Also check around window air conditioning units. (Distribute points to your judgement. If half the windows are caulked and weatherstripped, give 3 points.)	6	0	____
10. Are all doors to the outside properly weatherstripped? Also check around attic entrances inside the home. Test for weatherstripping by closing the door on a sheet of paper. If it pulls out easily, the door is not properly weatherstripped. (Distribute points to your judgement. If half the doors are well weatherstripped, give 3 points.)	6	0	____
11. Does your home have a fireplace?	0	5	____
12. Is the fireplace damper tight-fitting? (Can you see daylight around the damper?)	1	0	____
13. Is the fireplace damper closed when not in use? Otherwise, heating and cooling is lost up the chimney.	1	-1	____
14. Does the fireplace have a glass screen?	2	0	____
15. Have storm windows been installed over all windows, or are all the windows double-paned glass?	15	0	____
16. Does your home have storm doors or metal doors? Wooden doors do not provide extra insulation so you do not earn any points.	2	0	____

	Yes	No	Pts.
SUB TOTAL (9-16) Maximum Pts.-34 Minimum Pts.-10			____

HEATING & COOLING EQUIPMENT - If your home does not have central air conditioning or window units, skip to Hot Water Usage.

17. Is the filter for the heating/air conditioning system changed regularly?	1	0	____
18. Is the heating and cooling equipment given a yearly maintenance check? (Equipment that does not work properly wastes a large amount of energy.)	1	0	____
19. Are windows and doors tightly closed when the heating/cooling system is on?	2	0	____
If your home does not have central air conditioning, skip questions 20-22.			
20. Ask your parents if the heating and cooling ducts (located in the attic) are fully covered with duct insulation.	4	0	____
21. Is the thermostat set at a nighttime temperature of 60 degrees or below and at a daytime temperature of 68 degrees during the heating season? (Each degree above 65 degrees adds 2% to the heating bill.)	4	0	____
22. Is the thermostat set at a temperature of 78 degrees during the cooling season? (Each degree below 78 degrees adds 3% to the cooling bill.)			____
SUB TOTAL (17-22) Maximum Pts.-4			
(Home with window air) Minimum Pts.-3			____
Maximum Pts.-16			
(Home with central unit) Minimum Pts.-11			____

HOT WATER USAGE

Following heating and cooling the house, the water heater is the next largest user of energy in the home - using about 15-20% of the energy.

	Yes	No	Pts.
23. Is the water heater insulated with a jacket around the outside of the tank?	1	0	____
24. Are the hot water pipes insulated if they are in the garage or attic, or under the house?	1	0	____
25. Is the water heater kept free of mineral deposits? (The water heater should be drained about every 3 months.) NOTE: Do not start draining water heater one year old or older as this may cause leaks.	1	0	____
26. Is the water heater temperature set at 130 degrees (if a dishwasher is used) or 120 degrees (no dishwasher)?	1	0	____
27. Are flow restrictors installed in showerheads?	1	0	____
28. Are there any leaky hot water faucets?	-1	1	____
29. Do members of your family take short showers or use only small amounts of water for tub baths?	1	0	____
30. Do family members plug the drain and use sink water to shave or shampoo or wash dishes? Remember, hot running water is wasteful and costs money.	1	0	____
31. Are household cleaning tasks done with cold water?	1	0	____
SUB TOTAL (23-31)			____
Maximum Pts.-9			____
Minimum Pts.-5			____

APPLIANCES

Check your energy habits. Not all the appliances menticned are found in every home, but they are important energy users.

32. Are major appliances, such as washers and dryers, used during the early morning, or late evening hours, and weekends when utility demand is not at its peak?	1	0	____
33. Are the gaskets around refrigerator, freezer, and oven doors tight?	1	0	____

	Yes	No	Pts.
34. Is the range or oven turned off immediately after use?	1	0	____
35. Is the oven used to bake more than one food at a time?	1	0	____
36. Is the oven ever used as a dryer or heater?	-1	0	____
37. Are electric space heaters used only when necessary?	1	0	____
38. Are the proper sized pans used on surface units?	1	0	____
39. If you have a microwave oven, is it used for the major portion of cooking instead of the conventional oven?	1	0	____
40. If you have a clothes washer, is it used only for full loads? Remember to select the correct water level.	1	0	____
41. Is cold water used for the majority of washes?	1	0	____
42. Are clothes always rinsed in cold water?	1	0	____
43. If you have a dryer, is it used only for full loads? One item at a time is not good energy habit.	1	0	____
44. If you have a dryer, is the dryer lint screen cleaned after each load?	1	0	____
45. Are clothes line-dried if possible?	1	0	____
46. If you have a dishwasher, are dishes washed only when there is a full dishwasher load?	1	0	____
47. Is the frost on the freezer less than ¼ inch thick?	1	0	____
48. Are lights and appliances turned off immediately after use?	1	0	____

	Yes	No	Pts.
SUB TOTAL (32-48)			____
Maximum Pts.-16			____
Minimum Pts.-10			____
TOTAL POINTS			139 ____

ENERGY CHECK REPORT

I. INSULATION

1. Does any insulation need to be added? If so, how much is needed to bring the R-Value up to an R-19? an R-30? (Subtract the present R-Value from R-19; from R-30.) Example:

```
 R-19
-R-11
 R- 8   R-Value of 8 needs to be added.
```

2. Is wall insulation needed?

3. If you have a house on piers, does it need to be skirted?

II. VENTILATION

Does any ventilation need to be added? Where?

III. GLASS

Does any glass on the east and west need to be shaded? What do you think would be the best way to shade the glass?

IV. AIR LEAKAGE

1. Are there any windows and doors that need to be weatherstripped and caulked? How many?

2. Can the fireplace be improved? How?

3. How many windows are in the house? Do any need storm windows?

V. HEATING AND COOLING EQUIPMENT

Do any improvements need to be made such as filters or thermostat settings? List improvements:

1.
2.
3.

VI. HOT WATER USAGE

What improvements can be made in using hot water?

1.
2.
3.

VII. APPLIANCES

What improvements can be made in using appliances?

1.
2.
3.

VIII. Was the audit difficult to do?

IX. Do you think this is a good learning experience? Why?

X. What did your family think of this audit? (Have parents write brief comment, if possible.)

NOTE: Your parents may be interested in having an inspection performed on the home by a qualified inspector. Tell them about the GSU Home Inspection.* If they are interested, have them call the nearest GSU office for an appointment.

* Other utilities should be contacted for information on their home inspection programs.

HOME ENERGY EFFICIENCY SCALE

Remember - if your home scored the minimum points or less under any section, your home is an energy-waster in that area. Find the line that indicates the type of heating/cooling system your home has. Then look for point scale and circle. Example: home with window unit scores 70 pts.*

Description	Point Scale	Recommendation
With Central Unit	80 pts or more	Your home and habits rate high in being energy-efficient. Keep up the good work. Consider making further improvements in areas needed.
With Window Unit	79 pts or more	" "
With Other Method of Heating/Cooling	76 pts or more	" "
With Central Unit	67-81 pts	Fairly energy-efficient Need more work to make home and habits more energy-efficient.
*With Window Unit	52-79 pts	" "
With Other Method of Heating/Cooling	49-76 pts	" "
With Central Unit	Below 67 pts	Wasting too many dollars on energy use. Take immediate action to cut down on energy waste. Decide first on projects that cost little or nothing to do.
With Window Unit	Below 52 pts	" "
With Other Method of Heating/Cooling	Below 49 pts	" "

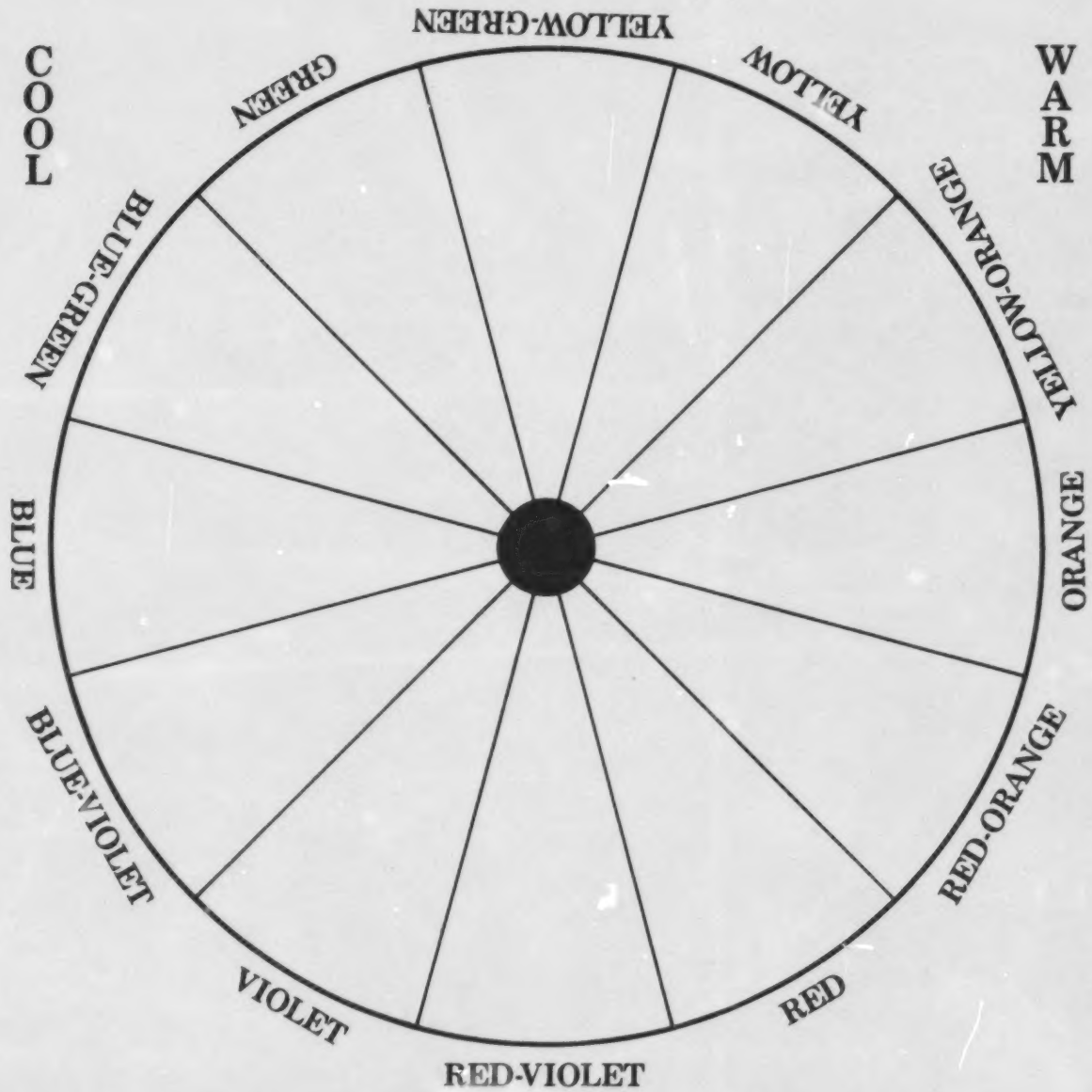
THE COLOR WHEEL

Colors can be divided into two categories, the cool colors and the warm colors.

Colors on the warm side of the wheel are the colors of the sun, heat and fire that create warming effects.

The cool colors reflect water, sky, shadow, ice which have a cooling effect on us.

Two colors, yellow-green and red-violet may be considered transitional.



WHICH COLOR HOLDS HEAT LONGEST?

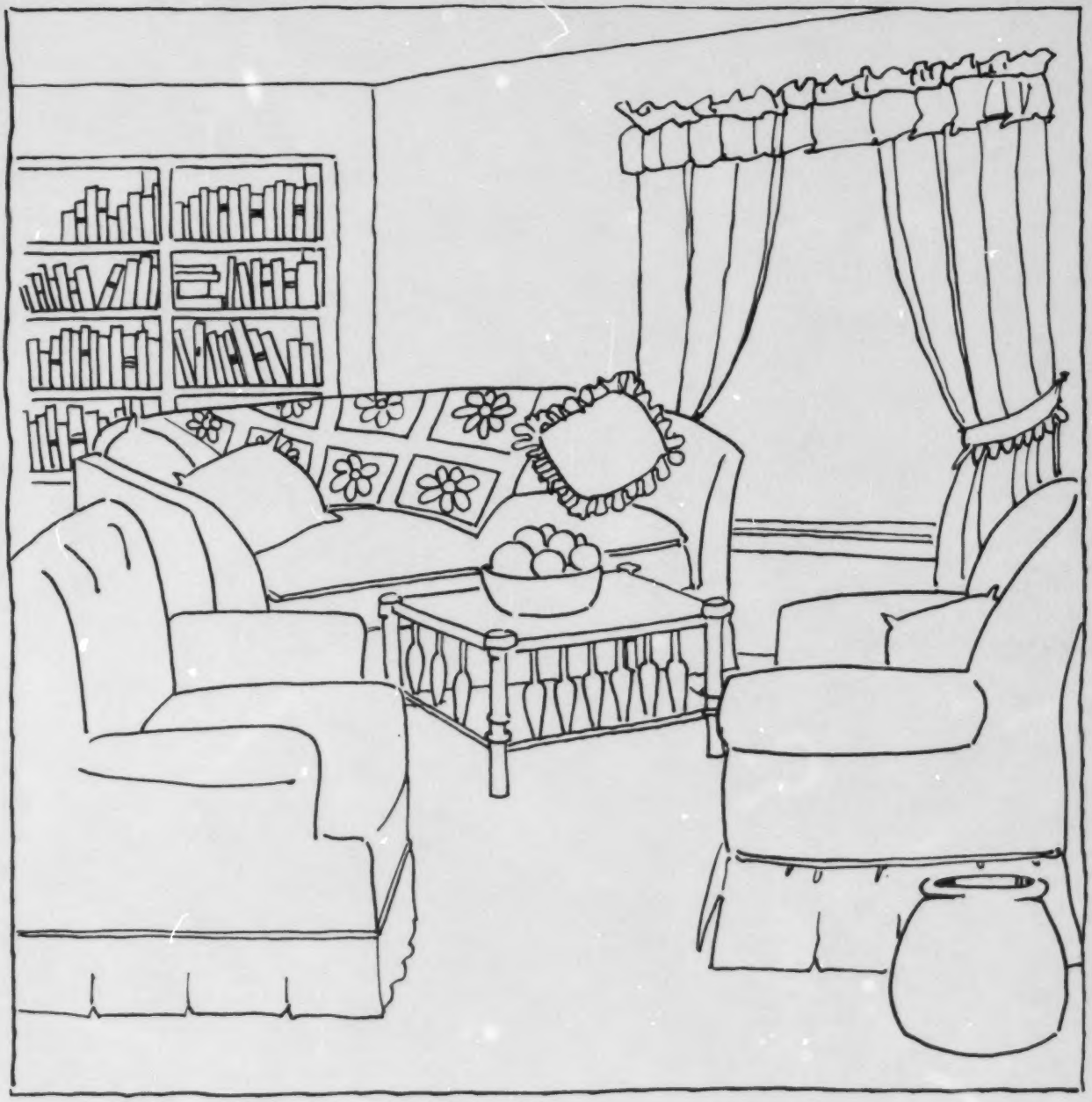
MATERIALS: 4 juice cans
Enamel spray paint: white, black, green, and red, Hot water (close to boiling), 4 thermometers, Food colors

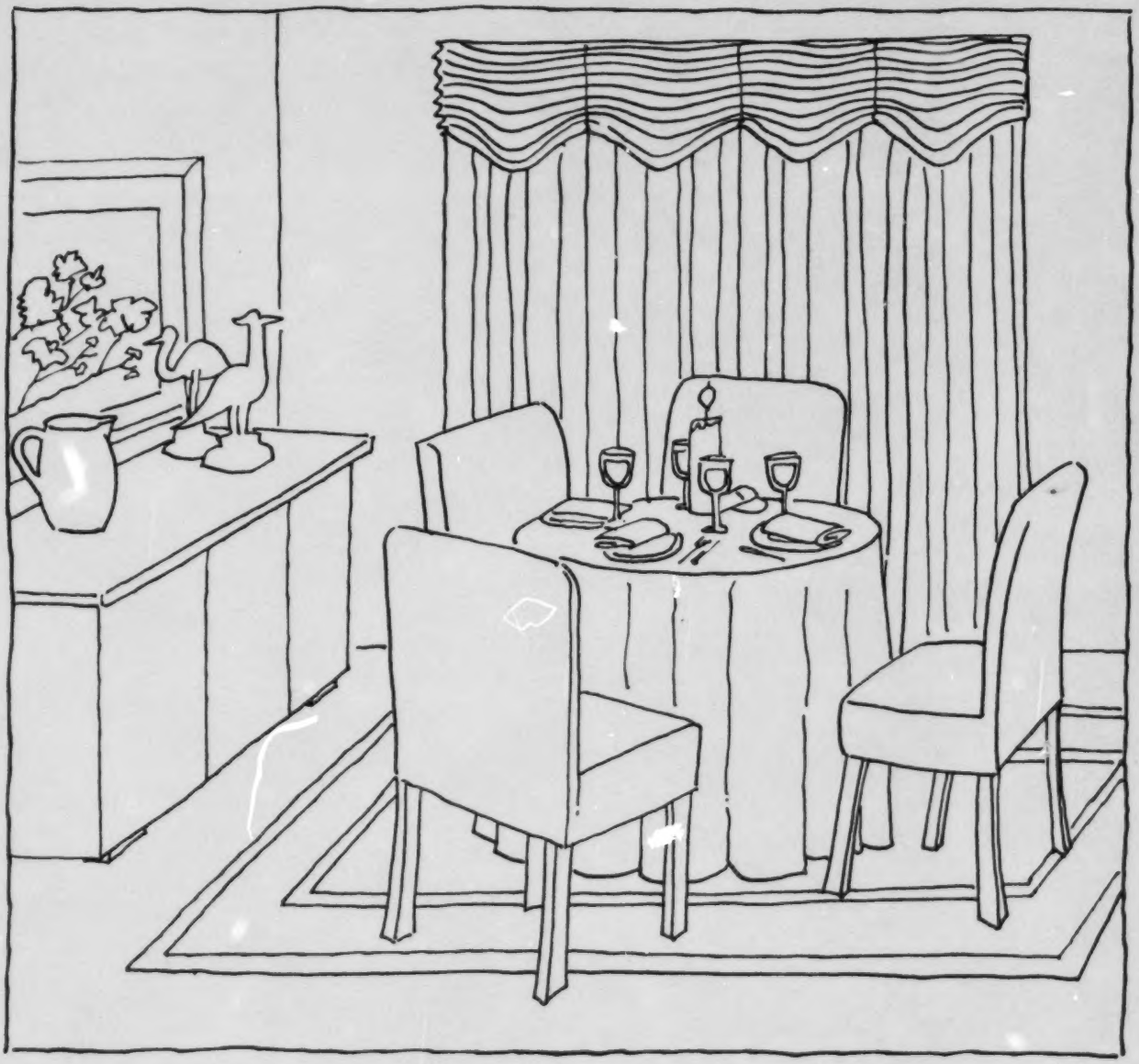
GOAL: To determine which colors absorb the most heat.

PROCEDURE: Paint each cup a different color, then fill each cup with the same amount of hot water. Add food color to the hot water. (Add drops of all the colors together to get black.)

Put the thermometer in each cup. Record the temperature every three minutes until the water cools. Make a graph of the results.

* Other types of paint won't adhere to surface.





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ENERGY-EFFICIENT TEXTURES

INSTRUCTIONS: Cut out of interior materials used to indicate energy efficiency.

I. Drapery and Upholstery Fabrics

Cool Fabrics

1. 2. 3.

Generic Name	Generic Name	Generic Name

Warm Fabrics

1. 2. 3.

Generic Name	Generic Name	Generic Name

II. Floor Coverings

1. 2.

Warm Qualities Cool Qualities

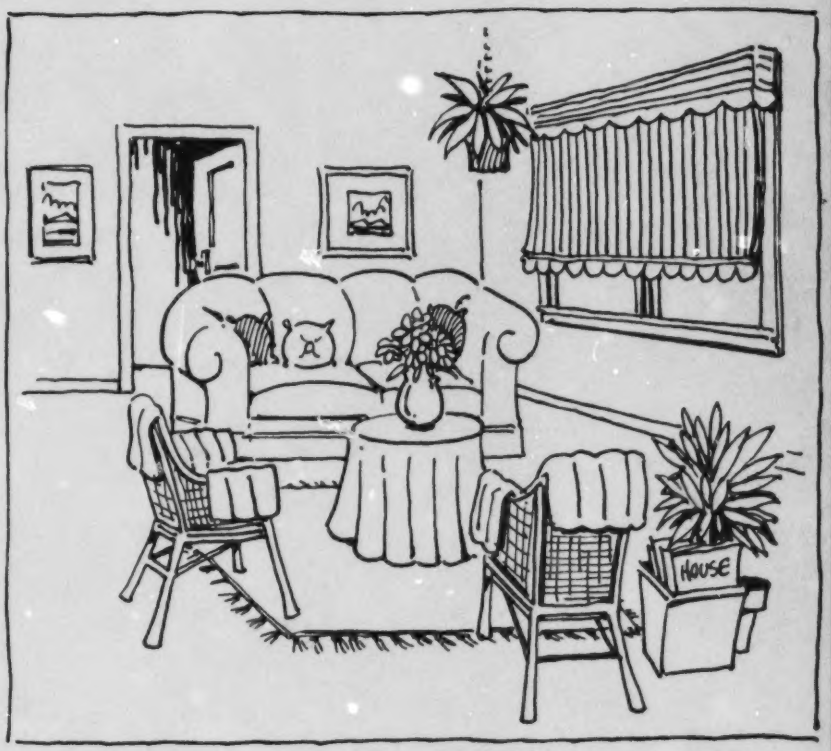
III. Wall Coverings

1. 2.

Warm Qualities Cool Qualities

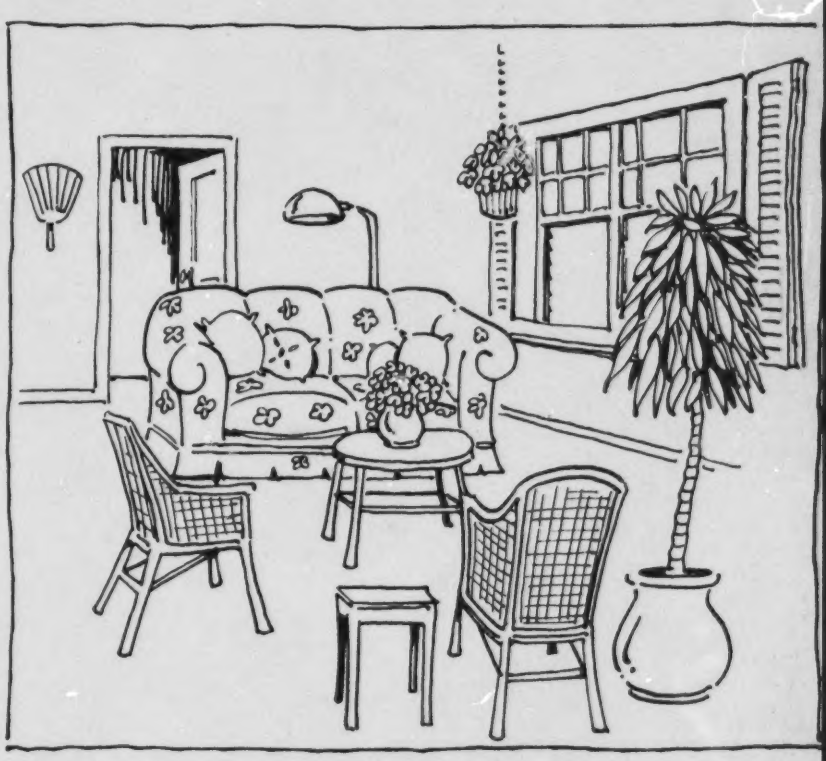
WARMING A ROOM

A COZY, WARM FEELING is created through visual and textural techniques. Napped, soft fabrics feel warm to the touch. Warm colors for area carpet and pillow accents add to the mood. THE CASE FOR..SEASONAL DECORATING. You can raise or lower the apparent temperature of a room by utilizing a seasonal decorating plan just as great-grandmother used to practice when rugs were rolled up and stored in the summer, the heavy drapes came down and gave way to simpler, airier window treatments, and crisp slipcovers gave furnishings a cooler look and feel. Seasonal decorating was standard procedure, the changes gave an emotional lift, refreshed the eye, and made furnishings last longer, too. Then along came air conditioning and cheap heat and seasonal decorating got lost n the shuffle. Its rebirth may take a bit of attitude adjustment for some, but it makes a lot of sense--and cents, too.



COOLING A ROOM

TO CREATE A COOL FEELING quilted chair throws are removed. A smooth, cool shiny fabric slipcover is tucked and tied over the sofa. Uncovered table and windows, more plants, cool fans and accessories contribute, too. When people think of seasonal decorating, they usually think of summerizing. But with the popularity of rattan, wicker, small scale furnishings, many 'temporary' pieces are becoming somewhat permanent, AND, with the soaring costs of heat, the trend may be to consider what can be done to winterize decor. Adding padding or coziness with quilted or textured throws, easy slipcovers, table covers, runners, comforters, screens, pillows, padded art, area rugs, etc. can be easily accomplished. The texture of fabrics can provide insulation in the winter through the thermal resistance of the fabric and the air film around it. (This principle is important in the layering of clothes in the winter, too.) Carpets, wall hangings and insulated draperies all increase the actual R-Value (resistance to heat and cold) of the exterior surfaces.



SOURCE: Energy Saving Decorating, Judy Lindahl, P. 28, 29.

ENERGY-EFFICIENT DECORATING

COZY VS. SPARSE DECORATING

Studies show that rooms decorated to give a feeling of coziness also tend to impart a feeling of warmth. The American Society of Heating, Refrigerating and Air Conditioning Engineers tested people in a cozy and a sparsely decorated room. Though tests showed that skin temperature was the same in each, people reported feeling warmer by several degrees (as much as 2.5 degrees in one study) in the cozier atmosphere. By contrast, a very spread out room arrangement fosters feelings of spaciousness and draftiness which can make one feel cooler.

COZY (WARM)	VS	SPARE (COOL)
1. Plump rounded lines		1. Clean straight lines
2. Lots of accessories and collectibles		2. Few accessories
3. More individual pieces		3. Fewer furnishings or single-look modules
4. Broken spaces		4. Open spaces
5. Low Ceilings		5. High ceilings
6. Covered windows		6. Uncovered windows

PADDED VS. STRUCTURAL: Extra padding can make a difference in how we perceive our surroundings. In general, we feel warmer when we surround ourselves with softer, fuller, textured fabrics, furniture and carpets. A decidely cooler atmosphere is achieved with sleek, smooth, spare surfaces.

WALLS: The high tech look of 'mover's pads' applied to walls not only insulates and adds texture and warmth, it can hide a multitude of sins as far as the condition of the walls beneath. Cracks, rough surface, stains, pipes, even doors and windows can be concealed with careful application.

Walls can be 'upholstered' by adding a layer of polyester fleece (Pellon) Thermolam 'Plus' (Stacy) needlepunch, quilt batting or foam. Ready quilted fabrics (some have foam filling), bedspreads, comforters, drapery fabrics are another excellent source of the padded look for walls.

FURNISHINGS: The rounder, softer, fuller upholstered looks are gaining in popularity and contribute to a warm, comfortable feeling. For coolness, contrast their effect with spare, square, clean lines. Comforters and quilts add texture when used as tablecloths and runners, slipcovers, pillows, even window hangings.

FLOORS: The texture, softness, and insulating value of carpeting vs uncovered wood, vinyl, tile, slate or marble flooring will come under more scrutiny by the energy conscious. Brick and quarry tile do give some feeling of warmth due to their warm rust colors and when properly planned and installed can be used to retain heat in passive solar applications.

It is not unusual to see carpeting used on walls and platforms to take advantage of insulating and sound dampening qualities.

NOTE: If you live in a climate of extremes, you might choose hard floors with loose-lay carpet or area rugs that could be taken up during summer months.

SOURCE: Energy Saving Decorating, Judy Lindahl

HOW TO ACHIEVE SEASONAL DECORATING

WARMING IT UP		COOLING IT DOWN
. Use area rugs or carpets on wood floors. Warm colors and/or textures.	FLOORS	. Remove rugs for bare floors or cool-look carpet. Bleached wood or light color tile or flooring beneath.
. Drapes or layered curtain and shade window treatments, shutters with shades, cornices, valances.	WINDOWS	. Light drapes or remove drapes and use shades, shutters, sheer curtains, or folding screens.
. Warm colors and/or textured upholstery. Fabric that feels warm. Quilted fabrics, brushed and napped surfaces.	UPHOLSTERY	. Crisp, cool, smooth, fabrics and colors for slipcovers. Cotton, canvas, glazed chintz, linen are good choices.
. Fewer plants, ceramic pots . Quilts, hooked rugs, soft sculptured, darker and warmer colored art. . Warm, textured pillows	ACCESSORIES	. Massed plants, use basket or reed pot covers . Light, airy, open, prints, posters, or fabric hangings. . Cool color pillow covers.
. Incandescent light gives warmer colors and more heat; highlights warm colors, dulls cool colors. Fluorescent (Warm White Deluxe) uses less energy, gives more light	LIGHTING	. Try cool color lighting (fluorescent) in living spaces, but not kitchens, because of color effects on red tones. Cool White Deluxe accents cool colors and dulls warm colors.

Furniture should be arranged to avoid drafts near doors and windows and other cool spots in the home. In warmer climates furnishings should be placed to catch air currents. In winter, objects should be placed in the sun's path to absorb heat and radiate it back later. Conversely, in warm weather windows should be shaded and furniture arranged to prevent heat damage or absorption. Furniture should not block air circulation around radiators, heating ducts, air conditioners, or baseboard heaters.

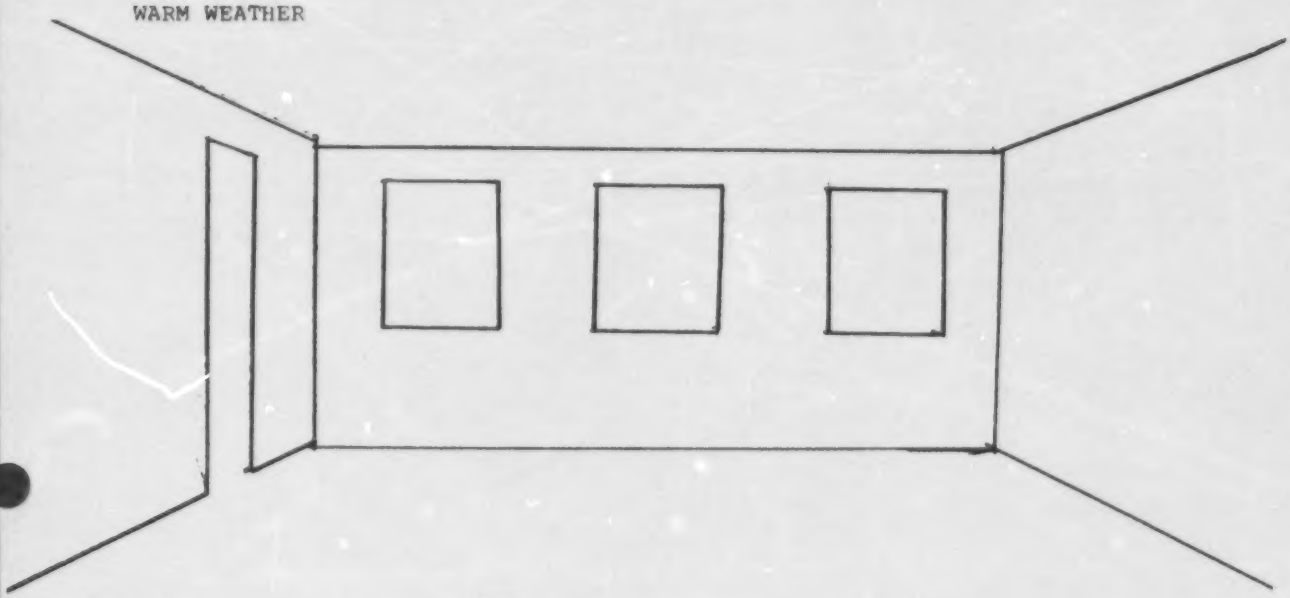
NOTE: Since we are encouraged to uncover windows in winter to take advantage of solar heat gain, some windows may need treatments with shades of materials that stop ultra-violet rays (which fade furnishings) while letting heat in.

SOURCE: Energy Saving Decorating, Page 30, Judy Lindahl

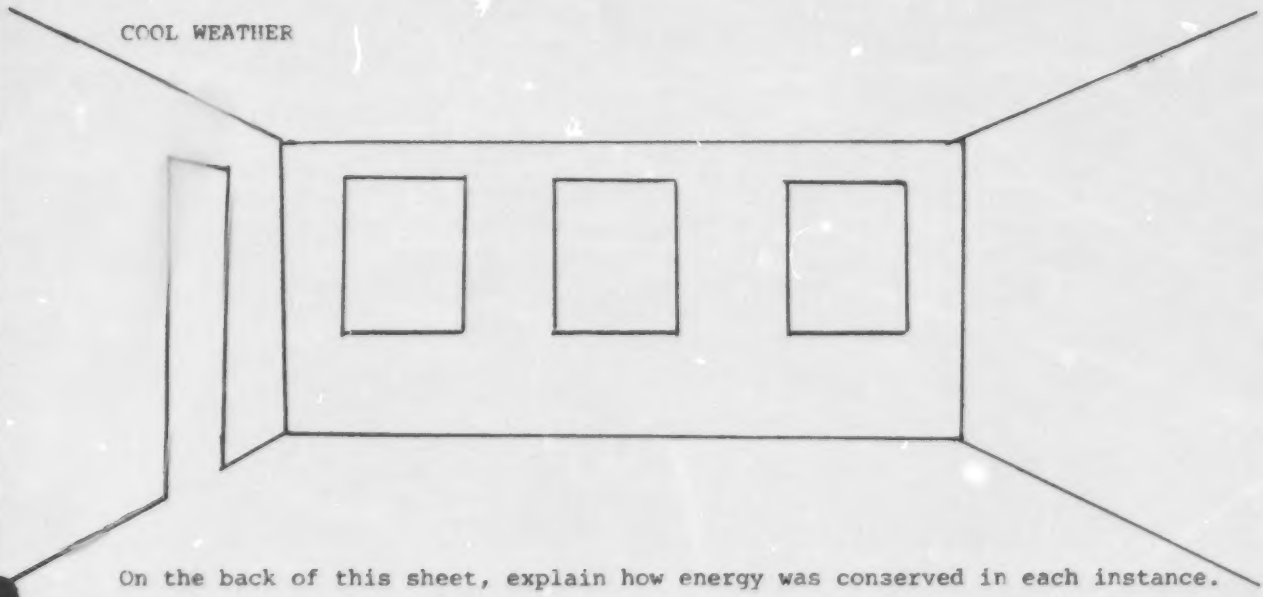
DECORATE TO SAVE ENERGY

Demonstrate the principles of energy-saving decorating by drawing or writing in furnishings and window, floor, and wall treatments in the two rooms below. Label colors, materials, textures, etc. that contribute to psychological feelings of warm and cold temperatures.

WARM WEATHER

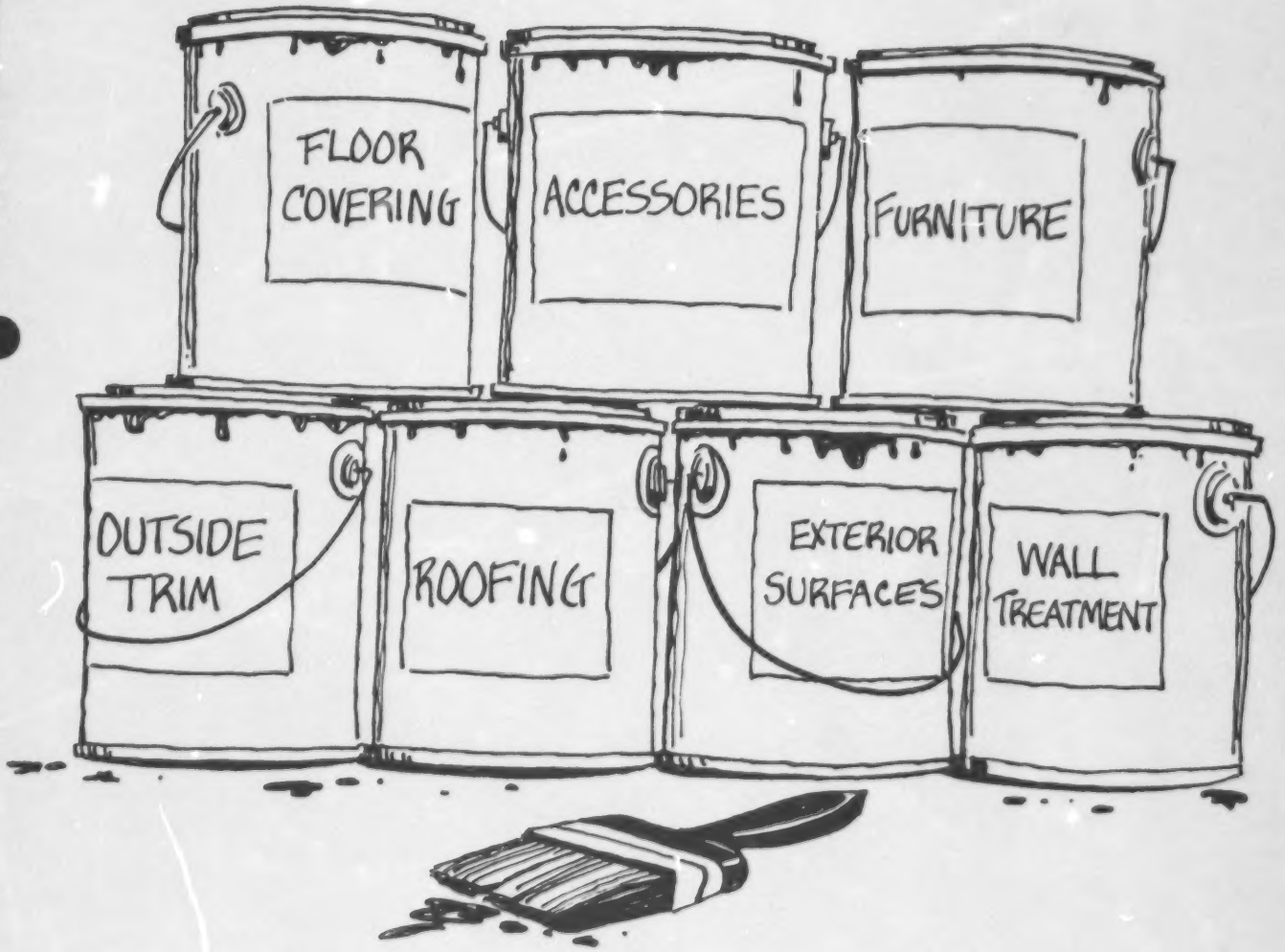


COOL WEATHER



On the back of this sheet, explain how energy was conserved in each instance.

COLOR CONSERVATION



COLOR THE ENTIRE HOUSE TO ACHIEVE THE BEST POSSIBLE ENERGY SAVINGS FOR THE SUMMER MONTHS.

ENERGY-SAVING WINDOW TREATMENTS

Windows are a major source of heat loss and gain in the average American home. Clear plate glass windows can conduct up to 20 times more energy than a comparable area of standard insulated wall. To combat this problem, people are investing in a variety of items to make their windows energy efficient, such as inside or outside storm windows, landscaping, solar films, solar screens, thermal drapes and mini-blinds. With all of the choices, which one is most efficient?

The first thing to remember is that an outdoor shading device is seven times more effective than inside shading devices such as drapes, shades, etc., because the sun is actually stopped from entering the house. But sometimes outside devices are not possible and many times do not match the design of the home. So, let's look at what you can do to existing windows to improve their shading and insulating abilities.

There are three principles of efficient window treatments. First, they must be well-sealed to prevent air and moisture flow. Second, treatments must be resistant to heat transfer, and lastly -- to save enregy -- they must be used.

DRAPES

Because conventional drapes are not sealed, they cannot protect against heat transfer as air is free to circulate between the drapery and the window.

To trap air between the window and the drapery, the top, sides, and bottom should be sealed. The top can be sealed by using a cornice board or lambrequin. Other options are hanging drapes from the ceiling or using a "board system" that creates a ceiling mount. The drapery can be sealed at the sides with velcro or magnetic strips or tacks. Velcro and magnetic strips work well for sealing the center, and the bottom can be sealed by having the drapes touch the floor.

Some other ready options for improving the efficiency of drapes are to add a shade or more layers under the drapes. The extra layers could be linings and/or sheets and should also be sealed.

SHADES

Adding shades can be one of the easiest and least expensive ways of improving the efficiency of existing treatments. To give maximum savings, the shade should be mounted so it fits close to the window.

There should not be any more than 1/8" - 1/4" clearance between the edge of the shade and the window jamb. If possible, the edges should be sealed with velcro, magnetic strips, plastic channels or similar material. The top can be sealed by stapling or taping a strip of clear vinyl or insulating lining along the top of the window casing so it rests on the shade as it rolls and unrolls. Heavy vinyl or reflective materials are more efficient shade fabrics than plain fabrics. Roman shades have a builtin top seal.

SHUTTERS

There are several options for improving the efficiency of louvered or fabric panel shutters. A shade can be added behind them or a Roman Shade over them. Also, an insulating layer could be attached on the back of the shutters. Solid shutters are more efficient than other types of shutters and should be weatherstripped.

Venetian blinds or the popular mini-blinds should not be used as part of a layered system because they do not seal the window.

Thermal shutters can be made or purchased. The shutters hinge or slide in place. The material used in making the shutters varies. The thickness may be 1 to 4 inches, depending on the frame used. The R-value varies according to the thickness. The shutters should be weatherstripped well, so that they fit snugly into the window and create a dead air space.

The inside of the shutter can be made of several different types of insulative fill, including foam, plastic or fiberglass insulation. The insulative filling can then be covered with painted cardboard, fabric, wallpaper, or whatever you choose.

WINDOW STUFFER

The window stuffer fits snugly into the window and thus increases R-value. Window stuffers can be left in the window or removed during the day to take advantage of passive solar gain. The stuffers can be stored under the bed, in the closet, or on the wall.

The window stuffer can be made of rigid board (expanded or extruded polystyrene or flexible board (spongelike polyurethane foam). The thicker the board, the greater the R-value. The insulative material is covered with fabric, wallpaper, or whatever you choose.

Low Budget - Energy saving materials for draperies you can make:

a. Budget blankets

b. Mattress pads

c. Bed sheets

ANATOMY OF A WINDOW INSULATOR

Not every shade, shutter or curtain can serve as a window insulator. Obviously, a sheer nylon curtain won't be much of a match for January winds. An effective window insulator usually has these features:

1. Outer covering (faces the room): Should be sturdy enough to hold the insulation in place and protect the device from moisture. For a shade or curtain, the outer covering must have some body to it. Firm, tightly woven fabrics such as kettlecloth, duck and most drapery fabrics are preferable to muslins or other loose weaves. Polyester blends wear well and are wrinkle-free. Cottons with a permanent press finish, such as seersucker, plisse or linen upholstery fabrics, are other good choices. Fabrics should be shrink-resistant.

2. Linging material (faces outsides): Should be light in color, and resistant to sunlight, moisture and shrinkage. For summer use a white liner will help to reflect back sunlight, as will any aluminized fabric.

3. Insulating material: Provides most of the device's resistance to heat flow (R-value). It can be an air space, polyester fiberfill in sheet form, or plastic bubble film.

4. Vapor barrier: A must to prevent condensation on windows and in the device itself. It can be flexible plastic film, such as 4-mil polyethylene or lightweight clear vinyl. For shades, vinyl is preferable since it tends to crinkle less when the shade is raised.

5. Edge seals: Help achieve the maximum R-value by preventing air flow in and out behind the device. These can be self-stick magnetic strips, velcro, or wooden side clamps. (A top seal is important in summer.)

SOURCE: Energy Saving Decorating, Judy Lindahl

R-VALUES FOR DIFFERENT TYPES OF WINDOW TREATMENTS

Window Treatment 3' x 5' window)	Total R-Value of Window Area (Approximate)
Single-Pane glass* (no treatment)	1.01
Single-pane with either storm or double-glazing (i.e., glass, plastic or polyethylene sheeting)	2.2
Single-pane with Insulative Roman Shade (with reflective plastic thermal back)	4.2
Single-pane with Insulative Thermal Shutter (if insulation used has R-Value of 8)	10.0
Single-pane with rigid foam expanded polystyrene Window Stuffer (Approximate R-4/inch)	
1" thick	5.9
2" thick	9.9
3" thick	13.9
4' thick	17.9
Single-pane with plastic foam (flexible) window Stuffer (R-3.69/inch)	
1" thick	5.6
2" thick	9.3
3" thick	13.0
4' thick	16.7

(*Wood sash, 80% glass)

SOURCE: Window and Doors, Public Service Company of Colorado, Denver, Colorado.

WINDOW COVER PROJECT

OBJECTIVE:

To build, decorate, and install an insulating window cover.

MATERIALS:

One 4' x 8' sheet of 1" rigid styrofoam insulation
30 lineal feet of wood lattice, 1 1/8" x 1/4"
Two plain cabinet knobs with screws or 2 screw eyes
Elmer's glue
One of the following: decorative fabric, wallpaper, foil, cork, ¼" plywood, or latex paint
30 lineal feet of weatherstripping

TOOLS:

Pencil and paper
Steel measuring tape or carpenter's rule
Utility knife
Hand saw
Staple gun
Mitre box (optional)

DIRECTIONS:

1. Carefully measure the inside casing of the window to be fitted with an insulating cover. Record the height, the top width, and the bottom width. If the width measurements differ by greater than 1/8", you should make a paper or cardboard pattern of this non-standard opening before proceeding.

2. Subtract 1/8" from both the width and the height.

3. Using the adjusted width and height measurements, mark off in pencil the panel to be cut from the styrofoam sheet. Or, if you have made and trimmed a pattern, pin it to the styrofoam as a guide.

4. Hold the styrofoam sheet steady while you carefully cut out the panel with the utility knife. Score the styrofoam lightly in the first cut. Increase pressure on succeeding cuts until you cut all the way through.

5. Check your panel against the window for closeness of fit. Trim only if necessary because a tight fit is essential. You will find slight "give" in the material that will compensate for slight imperfections.

6. Cut the lattice strips with a hand saw to make a wooden frame for the panel. Start with exact dimensions of your cut piece and the make one of the following:

a. Box frame - each piece is the width or length of the panel less the 1 1/8" of the lattice. Glue the frame to the panel first, then staple each joint twice.

b. Mitered frame - each piece is the width or length of the panel. Ends are cut 45° with a mitre box. Glue frame to the panel, then staple each corner twice.

7. Consider the framed side of your panel the "outside": it will face the window. Now decorate at least the "inside" or room-facing area of your window cover. You may glue foil or cork to the room-face side. Or you may choose fabric or wallpaper to cover your panel. If so allow a 5" margin over both length and width dimensions. Cover edges of your panel and staple the material to the wooden frame in back. You can also paint your window cover by brushing on latex paint. Or you may prefer to cover the panel with plywood face. If so, frame both sides and then glue the plywood to the room-side face.

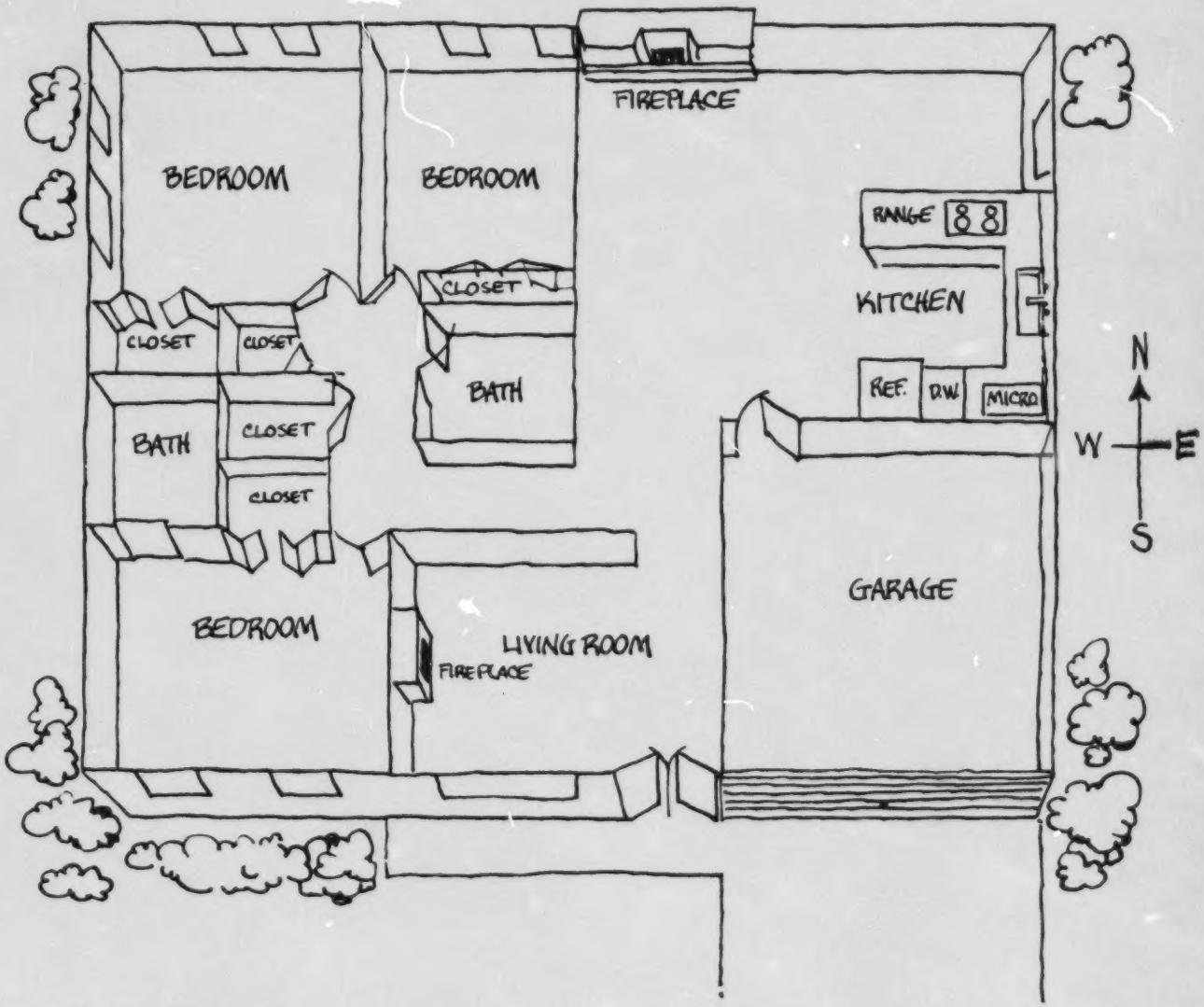
8. Add knobs or screw-eyes (for pulls) last. Put one on opposite ends of the room-facing side, in a convenient position for pushing on and pulling off the panel. If your window is small (about four square feet or less in area), one center knob is probably enough.

9. Apply weatherstripping around the window casing. This will help prevent infiltration.

10. Install the window cover. It should press tightly against the weatherstripping when in place. Yet it is lightweight and easy to remove whenever desired.

EFFICIENT EDITH:

1. AVOIDS BLOCKING HEATING AND COOLING REGISTERS AND FILTERS WITH FURNISHINGS.
2. REMOVES OBSTRUCTIONS TO AIR CIRCULATION.
3. ARRANGES SOFAS AND CHAIRS AWAY FROM WINDOWS AND DOORS.
4. PLACES STORAGE UNITS AGAINST EXTERIOR WALLS.



HASTY HARRY:

1. BLOCKS HEATING AND COOLING REGISTERS WITH FURNISHINGS.
2. OBSTRUCTS AIR CIRCULATION BY OVERCROWDING WITH FURNITURE.
3. PLACES SOFAS AND CHAIRS DIRECTLY UNDER WINDOWS AND CLOSE TO EXTERIOR DOORWAYS.
4. STRAINS THE HEATING AND COOLING EQUIPMENT BY PARTITIONING ROOMS WITH WALL UNITS AND LARGE PIECES OF FURNITURE.

LIGHTING BASICS

I. LIGHTING

A. TERMS

1. LUMEN - unit of light quantity produced by a light source

2. FOOTCANDLE _ amount of direct illumination on a surface one foot from the flame of a standard candle

3. One LUMEN per square foot equals one FOOTCANDLE

B. THREE TYPES OF LIGHTING NEEDS

1. GENERAL - 5-10 footcandles - a low level of light for activities such as:

a. Television viewing
b. Hallways
c. Stairs
d. Closets
e. Moving about
f. Most housekeeping

2. TASK LIGHTING - Localized light for a specific visual activity such as reading. Usually provided by portable lamps and by fixtures in utility areas.

a. 10-20 card playing
b. 20-30 casual reading, easy sewing, facial makeup
c. 30-50 household activities, in kitchens, laundry
d. 40-70 prolonged reading or study, machine stitching, musical activities, shaving
e. 100-200 fine sewing, hobbies with small details

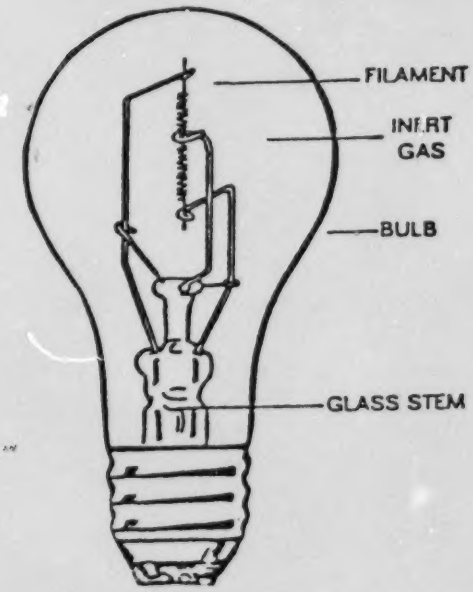
3. SPECIAL PURPOSE

a. Required for either security or special hazard areas where you need lighting at specific levels to ensure your own safety.

b. Accent or decorating lighting - Creates focal points, emphasizes pictures, art objects, and other cherished possessions, adds the personal and distinctive touch.

C. TYPES OF BULBS

1. INCANDESCENT BULBS - electricity passes through a tiny, minutely spiraled tungsten wire mounted inside the lamp causing it to become white hot and produce light.



a. Clear - This is similar in design to the light bulb designed by Thomas Edison in 1879. It produces a harsh, unshielded light source. Contrary to popular belief - it does not produce more light than an inside frost. Small clear flame-shape bulbs in a crystal chandelier add sparkle to a room - this is the only practical application of clear bulbs in the home.

b. Inside frost - Most commonly used lamps and are recommended for many lighting applications. It is inexpensive. however, it needs diffusing or shielding. Note the "hot spot" in the filament area. This bulb will produce reflected glare if not diffused.

c. Soft white (Deluxe white) - This entire white lamp glows - there is not bright spot. A special coating called "Q-coat" gives built in diffusion which softens the

shadows and reduces unnecessary glare. Not necessary to diffuse. Can be used in fixtures and in lamps. Special "eye saver" shape made by Westinghouse produces more "down" light for reading lamp.

E. REFLECTORIZED BULBS - incandescent bulbs that have silver or aluminum reflector coatings to direct the light where needed. Normally used for outside lighting, but can be used for inside.

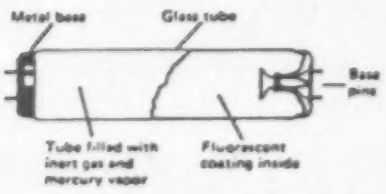
1. Reflector Flood Lamps - Spread their light over a larger area. To make every watt count you can replace all 100-watt bulbs in directional fixture with 50-watt reflector lamps for "task" lighting, such as for in-bed reading for the same amount of light.

2. Spotlight bulbs direct light in a narrow beam.

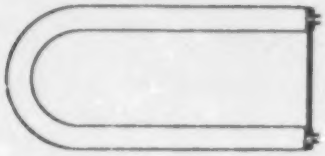
II. FLUORESCENT - Electric current flowing through the tube containing gases which cause the phosphorus coating to glow to produce light. The gases serve as a conductor to activate the phosphor.

a. Fluorescent lamps - There are 7 different "white" fluorescent tubes. Only deluxe warm and deluxe cool are recommended for the home because of the effect of the others on color and on people. Fluorescent lamps are usually used along with incandescents. Fluorescent lamps produce far more light and less heat than incandescents of the same wattage. Higher wattage indicates longer tubes with equal amount of light along entire surface. Used to create lines of light for built-in lighting in the home such as for valances and cornices with fluorescent tubes.

Fluorescent Tube Cross Section



Fluorescent "U" Tube

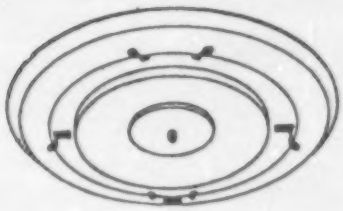


1. Deluxe warm - enhances warm colors - reds, yellow, browns, beige (etc.). Most nearly like incandescent.

2. Deluxe cool - Good color rendition to cool colors greens and blues. Recommended for use in room where dominant color is green.

b. Circular Fluorescent - replace incandescent bulbs in table lamps and ceiling fixtures.

Circular Fluorescent Tube with Fixture



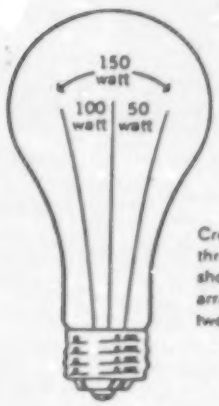
D. THREE-WAY LAMPS - Usually used in reading lamps. Requires 3-way switch. Two filaments that burn separately then together makes lamp 3-way. Third speed is the total watt of the first two speeds. When one filament burns out use in another socket

1. Medium base

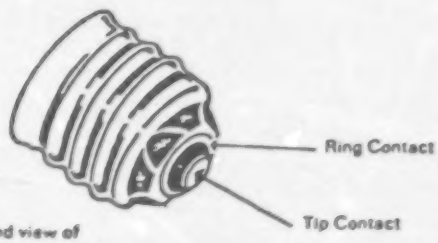
a. Inside frost and soft white 50-100-150 watt, 15-135-150 and 30-200-230 watts.

b. Mogul base - for floor lamps - 100-200-300 watts.

THREE-WAY BULBS



Cross section of three-way bulb showing schematic arrangement of the two filaments.



End view of three-way bulb showing two contacts in base.

FLUORESCENT VS. INCANDESCENT LIGHTING

OBJECTIVE: TO DEMONSTRATE THE RELATIVE ENERGY EFFICIENCY OF FLUORESCENT AND INCANDESCENT LIGHTING.

Wattage is not a measure of the amount of light given off by a light bulb, but how much energy is required to operate it. The amount of light it provides is indicated in lumens. Bulk packages should give not only the wattage required, but also the lumens produced by the bulb. Using bulb packages, compare several incandescent and fluorescent bulbs for efficiency (lumens per watt).

For example: A 100-watt incandescent bulb may yield 1750 lumens which gives the bulb an efficiency of 17.5 lumens per watt:

$$\frac{1750 \text{ lumens}}{100 \text{ watt}} = 17.5 \text{ lumens per watt}$$

Determine the efficiency of the following bulbs plus any others you may have.

A. 100 watt fluorescent bulb: $\frac{\quad\quad}{100 \text{ watt}}$ lumens = ____ lumens per watt.

B. 40 watt fluorescent bulb: $\frac{\quad\quad}{40 \text{ watt}}$ lumens = ____ lumens per watt.

C. 100 watt incandescent bulb: $\frac{\quad\quad}{100 \text{ watt}}$ lumens = ____ lumens per watt.

D. 25 watt incandescent bulb: $\frac{\quad\quad}{25 \text{ watt}}$ lumens = ____ lumens per watt.

1. Which type of lighting is more efficient -- incandescent or fluorescent?

2. Is it more efficient to buy four 25-watt or one-100 watt incandescent bulb(s)? _____.

Adapted from: Energy conservation in the Home, October, 1977.

WASTING ENERGY

TURN OFF LIGHTS
WHEN NOT IN USE.

USE FLUORESCENT LIGHTS
WHENEVER POSSIBLE.

USE THREE-WAY
BULBS IN TABLE
LAMPS.

SELECT FIXTURES THAT USE THE
LEAST NUMBER OF BULBS FOR THE
MOST AMOUNT OF LIGHT.

USE NO HIGHER WATTAGE
THAN RECOMMENDED
FOR THE FIXTURE

AVOID RECESSED FIXTURES
WHICH PENETRATE CEILING AND WALLS.

USE LIGHT COLORS
ON CEILINGS, WALLS,
AND FLOORS TO REFLECT
LIGHT.

USE STANDARD-LIFE LIGHT BULBS
RATHER THAN "LONG LIFE" BULBS TO GET
MORE LIGHT FOR YOUR DOLLAR EXCEPT
IN HARD-TO-REACH PLACES.

IS A TURN OFF

ENERGY-SAVING TIPS IN LIGHTING

1. Turn lights off when not in use.

2. Use fluorescents whenever possible. They produce four times as much light per watt as incandescents and last about seven times as long.

3. Use bulbs that give the most lumens for the least amount of energy consumed. One 150-watt is more efficient that two 75-watt bulbs. You receive more lumens from the same amount of wattage.

4. Use the right wattage bulb for the fixture. If the fixture calls for a 60-watt and you install a 100-watt, the additional heat produced may cause damage to the fixture and shorten the life of the bulb.

5. Install dimmer switches in those areas where they will benefit your needs.

6. Install permanent timers on outside lights. Use inside timers for lights when the family is away.

7. Reduce or eliminate ornamental lighting.

8. When decorating, use light colors on walls, floors and ceilings. They reflect more light into the room. Dark colors absorb light and will require higher levels of light input. You can get up to twice as much useful light on a task in a light colored room as in a dark one.

9. Utilize natural light by placing windows over work areas wherever practical.

10. Clean all lighting fixtures to maintain their efficiency.

11. Select fixtures that use the least number of bulbs for the most amount of light. For example, one 100-watt bulb gives more light than three 30-watt bulbs and uses less energy.

12. Avoid recessed fixtures which penetrate ceilings or wall insulation.

13. Buy bulbs by the light output per watt. Notice also the expected length of life of each bulb, which is printed on the package.

14. Use 50-watt reflector bulbs instead of 100-watt bulbs in pole lamps or wall units with bellshaped holders that are used for reading, lighting the piano, etc. Standard 100-watt bulbs trap most of the light in the holder. Although the 100-watt bulb has a lower initial cost, the small reflector bulb directs the light where it's needed, lasts two to two and one-half times as long, and uses half as much electricity. The same will hold true for the downlights over your sink or in other areas of the home.

15. Use three-way bulbs, instead of regular bulbs, in table lamps. They can be turned on HIGH for reading, and LOW or MEDIUM for conversation. The new 15/135/150 has an added bonus. At the 135-watt setting, it gives more light then the 150 level of the 50/100/150-watt, saving 15-watts of electricity. On low, it provides comfortable light for TV viewing, passage through a room, or as a night light.

16. New circular fluorescent units screw into regular incandescent bulb sockets and pay for themselves in energy savings. The circular units can be used in portable lamps, some ceiling sockets and pendant fixtures.

17. Ready-to-plug-in, 33-watt fluorescent tube units may be used under wall cabinets in the kitchen or dark areas where light is needed. The plug-in units may provide enough work light so that you can turn off the ceiling fixture.

18. Try a double 40-watt fluorescent fixture with a plug-in cord over work benches or laundry area. With this conversion, you can consume less energy and get three times the light and 20 times the life of the incandescent bulb.

19. Instead of an incandescent bathroom ceiling fixture, consider using two 20-watt (24-inch) Soft White fluorescent lamps - one on each side of the mirror -for make-up and grooming light.

20. Consider fluorescent lighting for kitchen ceiling fixtures. A double 20-watt fixture will do the same lighting job with about half the electricity used by a 100-watt incandescent bulb, two 60-watt bulbs, or four 40-watt bulbs.

21. Switch from 7-watt night light bulbs to the new, cooler 4-watt night lights and save almost half the electricity. The clear 4-watters appear almost as bright as the coated 7-watt bulbs. Low wattage night lights add little to the lighting bill even when used 10 or more hours per day.

22. Use standard-life light bulbs rather than "long life" bulbs to get more light for your energy dollar. Long life bulbs do last longer but they cost more to buy and are less efficient (they produce less light per watt than regular bulbs). Use them only in hard-to-reach places where the convenience of extra life makes higher bulb costs worthwhile.

23. Convert outdoor gas lanterns to incandescent post light bulbs, if possible. Otherwise, have the utility company turn of the gas lantern, and re-aim safety-security flood-lighting to illuminate the area.

24. Put outdoor safety-security lighting on a timer or photocell unit to turn them off automatically when not needed.

25. Use light color paint or paper on walls. Light-colored surfaces reflect more light, allowing use of lower wattage bulbs.

26. Keep ceiling fixtures clean to maximize their light outputs.

27. Don't overlight. Keep a small supply of right-sized bulbs at home so you're not tempted to use a higher wattage bulb when the regular bulb burns out.

APPENDIX C

TEACHER BACKGROUND INFORMATION

RENEWABLE ENERGY: AN OVERVIEW

Renewable energy technologies use the energy from non-depletable sources: sunshine, water flow and vegetation. The most common renewable energy devices are solar collectors, windmills, fireplaces, woodburning stoves and hydroelectric turbines, variations of most of these devices have been used for hundreds of years. Today, efficient versions are being developed to reduce our use of non-renewable resources, such as oil, natural gas and coal.

Solar Heating and Cooling

Solar energy systems fall into two major categories: active and passive.

Active Heating Systems

Active solar heating systems use hardware (pumps and fans) and require electricity to distribute and regulate heat. Heat is usually collected through flat plate collectors which are shallow insulated boxes covered with glass and containing a black metal plate. The metal plate absorbs sunlight and converts it to heat, much like the black upholstery in a car does on a sunny day.

Flat plate collectors are mounted where they will intercept the most sunlight: on a building's south facing roof. Air or a water solution flows throuth the collector, coming in close contact with the absorber plate.

The air or liquid is heated and stored in an air system, or a water tank if it is a liquid system. From storage, Heat is pumped throughout the building in the same way heat is distributed from a conventional furnace.

The most common and cost effective active solar systems are used for domestic water heating. Water heating systems are basically smaller versions of space heating systems.

Active Cooling Systems:

Three types of active solar cooling systems are being developed: Absor tion coolers, Rankine cycle coolers and desiccant coolers. Absorption coolers are the only systems market in the United States. They operate on the same principle as a gas-fire refrigerator.

Flat plate collectors are not efficient enouch to produce the high te peratures needed to run an air cond tioner. Instead, evacuated tube or concentrating collectors that are m efficient, but also more costly, ar used. Solar driven active cooling tems are currently too expensive fo general residential use.

Passive Heating Systems:

Passive space heating systems contain no mechanical parts and are often cheaper than active space heating systems. A passive system uses the structural components of a building (walls, windows and floors to collect and store solar energy. Heat is distributed by the natural process of convection, conduction and radiation.

In a passive solar building, most of the windows face south to let in as much sunlight as possible. Heat is stored in "thermal mass" -- thick masonry floors or walls, rock beds, water-filled containers or any combination of these. During the day, the thermal mass absorbs a great deal of heat, particularly if it is in direct sunlight. At night, the stored heat gradually migrates to the living area. In a strictly passive house, this heat moves naturally, without a mechanical boost. However, "hybrid" systems that incorporate fans or blowers

for added circulation are common. At night and during heavily overcast periods, movable insulation in the form of heavy curtains or shades is pulled over the southern windows to reduce heat loss.

Passive Cooling

Passive cooling is accomplished through the structure's design, layout and components, as in passive heating. Passive cooling techniques control incoming sunlight and use a variety of methods that encourage natural ventilation and create induced ventilation.

Sunlight can be kept out by shading windows with overhangs, trees or awnings. Movable insulation can be drawn over windows during the day to reduce heat gain.

Natural ventilation is encouraged by opening the building to summer breezes and providing a clear path for the air to move along. Induced ventilation depends upon use of the chimney effect, where hot air that accumulates is allowed to rise and exit rapidly through high vents. At the same time cooler air from another source (such as a well-shaded north yard) is drawn in.

Solar Economics

Professionally installed combined active solar space heating and hot water systems for average houses range from $10,000 to $20,000, depending upon the size of the system, the amount of heat the system is designed to provide, and your climate. Kits or owner-built installations are cheaper. Solar hot water systems alone range from $3,500 to $4,500 in northern climates and $2,000 to $4,000 in the Sunbelt.

Passive space heating and cooling systems add between 5 to 10 percent (or about $5,000 to $10,000) to the cost of a new home. Adapting an existing house to use passive techniques will cost about the same. Owner-built sytems can be less than $5,000, while custom-made systems may exceed $10,000.

Solar Electricity

The sun's energy can also be converted into electricity by using photovoltaic cells, solar thermal energy system or wind machines. Each of these systems may be used to power utility stations, shopping districts, small communities or singl homes.

Photovoltaic Cells

Photovoltaic (or solar) cells convert sunlight directly into electricity, without mechanical generators. The cells are usually composed of silicon, but other semi-conductor materials are also used. When sunlight strikes photoviltaic cells, electrons are dislodged, creating an electrical current which can then be drawn off.

Photovoltaic cells were first used to power space satelites in the fifties. At that time they were quite expensive, costing more than $1,000 per watt. Although they are still too costly for widespread use, their price has been brought down to about $10 per watt.

BACKGROUND INFORMATION

I. Caulking

A tiny crack around the window frame might seem insignificant. But add up all the inside and outside cracks of windows, doors, and other joints and you have opened the gates for energy waste. In American homes, 10 to 30 cents of every dollar spent for heating and cooling could be saved by minimizing the air leakage. When the house is well insulated, heating and cooling costs can be reduced by weatherstripping and caulking. Enough air passes through an average home in a day to fill up three Goodyear blimps. Air infiltration is air leakage that occurs both ways - whether it's air that comes in to reduce the home's comfort level, or "conditioned" air (hot or cold) that escapes to the outside.

Either way it ups energy consumption. So fill those cracks with caulking and weatherstripping - two sure methods that will improve your home's thermal envelope and your energy bills.

Caulking is for cracks around door and window frames, places where wood and brick siding meet, and joints between the chimney and siding. It should also be used where the house framing meets the concrete foundation and where water pipes, dryer vents and wires pass through walls. The best rule of thumb for caulking is to apply it any place where two different materials meet.

II. Caulking Compounds

There are several different types of caulking compounds that will do the job. Some last longer than others. Some are less expensive. And some are easier to apply. Still others come in attractive, decorator colors. Whatever your needs, keep the facts listed in the chart below in mind when choosing a caulking compound.

Caulking Compounds	Durability	Comments
Acrylic Latex	5-10 years	Easy to apply. Water clean-up, paintable, good elasticity.
Butyl Rubber	5-10 years	Solvent clean-up required, skillful application needed, not paintable.
Silicone	20 years	Familiar as bathtub caulking. Most durable, not paintable, instructions should be followed carefully, skillful application needed. Colors are available. Most expensive.
Oil or Resin Base	Less than Others	Easy to apply. Low cost.

III. Weatherstripping

Caulking's good companion is weatherstripping. It reduces air leakage around windows and doors where they meet the frame.

To check for leakage, close the door on a piece of paper. If the paper pulls out easily, weatherstripping should be added or existing weatherstripping is not placed correctly. Also, you can run your hand along cracks where moving parts of a window or door come together. Any windy day is a good day for this test.

Don't forget to check doors between conditioned and unconditioned parts of the house such as doors to the garage, workshop and attic.

Most weatherstripping materials are available at local hardware stores, lumber yards or conservation centers. And again, as with caulking, evaluate the different types and select one that fits your particular needs when making your choice of weatherstripping materials.

Weatherstripping	Durability	Comments
Rolled Vinyl with rigid metal backing	5 years	Must make complete contact for proper seal
Foam Rubber	1-2 years	Easy to apply. Short life span.
Thin Spring Metal	5 years and up	May lose some flexibility in time and therefore lose its sealing ability.

Weatherstripping should be checked every year for its condition. If installed coorectly the first time, it will be effective for years.

Look for other types of weatherstripping such as vinyl bulb, interlocking threshold, door sweeps, etc.

IV. Foam Gaskets

Just as the cracks around doors and windows allow air to come into the home, air also leaks through electrical wall outlets and light switches. 20% of the air leakage in the home comes through these outlets. Gaskets fit between the outlet and the coverplate and are fairly inexpensive - about 20¢ each. Be careful when installing these or you might get shocked. TURN OFF THE ELECTRICITY AT THE BREAKER BOX.

WATER HEATING CONSERVATION MEASURES

INSTRUCTIONS

HOW TO LOWER WATER HEATER TEMPERATURE

Lowering the temperature Setting on your water heater is very simple, The temperature dial on a gas water heater is located at the bottom of the water heater tank. To lower the temperature, just turn the temperature dial to the desired setting. Some water heaters have a cover over the dial and drain. This can be easily removed by lifting up and out.

To lower the temperature on your electric water heater, follow these instructions:

1. TURN OFF THE ELECTRICITY to the water heater at the fuse box or circuit breaker.
2. At the front of most electric water heaters there are one or two access panels that cover the temperature controls. Unscrew access panels and remove them.
3. Carefully part insulation so you can see the temperature dial. Depending on your particular water heater, you may have one or two temperature controls. If you have two controls (one under the top and one under the bottom panel), turn the temperature settings the same or set the top control slightly lower than the bottom control
4. Using a screwdriver, turn indicator to desired temperature setting.
5. Carefully replace insulation as you originally found it and screw access panels back on.
6. Turn on electricity to the water heater.

HOW TO INSULATE PIPES

If your hot water pipes are located in an unheated area, they can be insulated to reduce heat loss from the tank to the faucet. If the cold water pipes are located in an unheated area, it may also be necessary to insulate them.

Before insulating, you should repair any leaky pipes. Pipe insulation can usually be found in wrap-around insulation kits, flexible tubing, or rigid foam type. Make sure you choose the size that snugly fits your hot water pipes. You can purchase pipe insulation at hardware stores, building supply stores, plumbing firms and conservation centers. If you insulate your water heater and/or water pipes, make sure you save your sales receipts for Federal and possible State Tax credits.

HOW TO DRAIN THE WATER HEATER

To maintain the efficiency and increase the life of the water heater, it is important to get rid of the mineral deposits that can settle at the bottom of the tank. To do this, you would drain a bucketful of water from the drain valve about once a month.

This practice should only be done if your water heater is less than one year old or if you have been draining a bucketful regularly. Water heaters that have not been drained regularly may have drain valves that have become clogged and will not close once opened. If the drain valve does not open easily, do not force it open.

HOW TO INSTALL FLOW RESTRICTORS

Flow restrictors are vey inexpensive devices which reduce the flow of water in showers and faucets

without reducing the pressure. A flow restrictor can cut the water flow from 10 gallons to 2-3 gallons per minute. Remember this rule: Take short showers or partially-filled tub baths to conserve. Repair all leaky faucets. One drop a second can waste as much as 60 gallons a week

BACKGROUND INFORMATION
INSULATION

I. Definitions
   A. Insulation - material used in the construction of a home to retard heat loss in the winter and heat gain in the summer.
   B. R-Value - measure of an insulating material's resistance to heat flow or transfer. The greater the "R" number, the greater the insulating value.
   C. Vapor barrier - Waterproof material which is placed next to insulation. Used to prevent insulating material from becoming moist, as mositure reduces its effectiveness.

II. Purpose
The primary purpose of home insulation is to resist the flow of heat, whether it is heat escaping from the house in the winter or entering the house in the summer. If a home has no or very little insulation, then much heat will be lost from the home during the winter and much heat will move into the home during the summer.

III. Buying Information
   A. Fiberglass and mineral wool are fire resistant. Cellulose should be chemically treated to be fire resistant. The label on the bag will show if it meets federal specifications.
   B. Buy from a reputable dealer. Contact the Better Business Bureau if you are not sure.
   C. If having a company install the insulation, also make sure that the company does quality jobs.

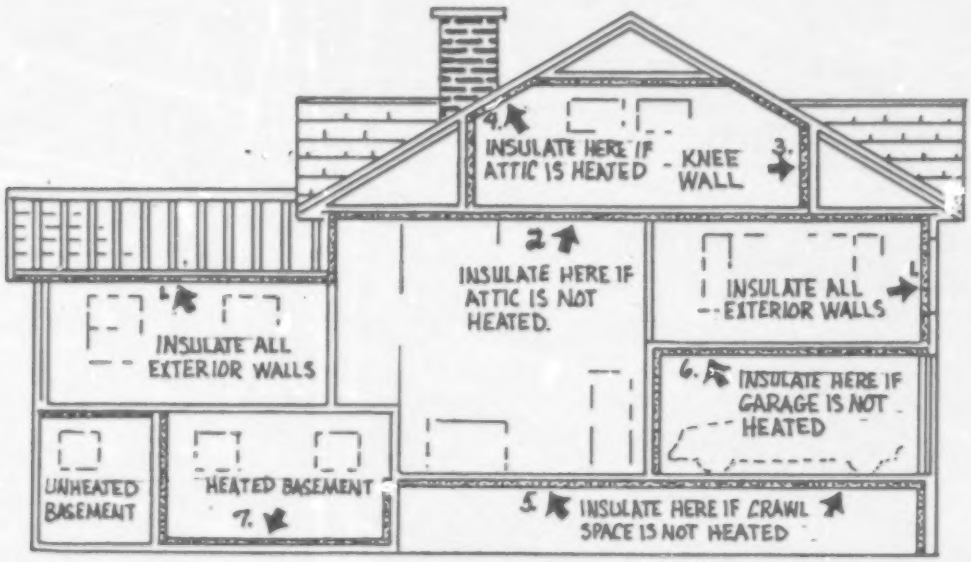
IV. Types of Insulation
   A. Loose fill or blown-in
      1. Loose material stored in bags and blown into areas of the home by a machine or that can be poured in by the owner.
      2. Used in attics or blown in walls of existing homes.
      3. Make sure product is an approved insulation and that you know the number of bags required to obtain a specific R-Value.
      4. Usually best to obtain a contractor to do the work.
      5. If done properly, it should fill all spaces.

   B. Batts or blankets
      1. Precut to fit specific area (attic floor, walls, and floor if house is on piers).
      2. Comes with or without vapor barrier attached.
      3. Packaged in rolls or stacked.

   C. Rigid Board
      1. Used as exterior sheathing on new home construction.
      2. Can be used to cover existing siding if new siding is being added.

V. Where to insulate a home (numbers relate to the diagram)

1. Exterior walls
2. Attic area above ceiling
3. Knee walls (wherever one side of the wall is exposed to the attic area)
4. Between collar beams and rafters.
5. Floors above crawl space
6. Floors over an unheated or open space such as a garage or porch
7. Heated basement



VI. Energy saving package for new homes

A. Using at least minimum R-Values in insulation:

attic or ceiling	= R-19 - R-30
sidewalls	= R-11 - R-13
floor (over crawl space)	= R-19
floor (over garage)	= R-19

B. Adequate caulking and weatherstripping of spaces around doors, walls, or windows, wiring and plumbing holes, foundation slab, and attic entrance.

C. Use of double paned glass on windows or use of storm windows and doors.

D. Use of air conditioning unit with high S.E.E.R. ratings -- 9 or higher.

E. Fireplace with installation of outside combustion air vents, glass doors and damper.

F. Adequate shading of east and west windows.

BACKGROUND INFORMATION
WINDOWS

I. Structural qualities of windows - a home loses about 30% of its heat through windows. Windows have a very low R-Factor but there are some structural features on a window that will reduce heat loss. It is difficult to eliminate windows completely because of their positive functions of letting in natural light, allowing ventilation and opening the home to exterior views.

Glass by itself offers almost no resistance to the passage of heat. It is the air on both sides of the glass, or between the panes of double glazing, that provides insulation. Single glazing has a total resistance to heat transmittance of only R-0.89; double glazing, only R-1.8. A resistance of R-11 to R-18 is common for an insulated wall. In other words, ten to twenty times more heat escapes through a square foot of window than through a square foot of wall.

II. Types of Windows

A. Single glazed - one pane of glass.

B. Double glazed - two panes of glass with dead air space between.

C. Triple glazed - three panes of window glass...creating two air spaces between the panes.

D. Aluminum framed - glass held in place by aluminum framing which is a great conductor of heat and cold.

E. All-wood framed - glass held in place by frames of wood which have less conductivity.

F. Vinyl-clad wood framed - a frame of wood holds the glass. On the exterior the wood is covered with a vinyl covering in order to eliminate painting the exterior of the window frame.

G. Storm windows - a pane of glass or other material placed on the inside or outside which creates a space between it and the original window, and reduces heat flow in and out.

H. Stationary (or non-operable) - a window that does not open. Usually has a tighter seal than a window that opens.

I. Plastic storm window - an inexpensive plastic sheeting to place over your window. Usually it is attached in late fall and removed in the spring.

J. Tempered glass window - a specially made glass that does not shatter when broken, therefore, is safer. It is required in some building codes where windows are placed close to an exterior door. It has no additional insulating value.

III. Ways to Increase Efficiency of Windows

A. Add weatherstripping to all sides of sash.

B. Replace glazing compound around glass every few years.

C. Install storm windows

D. In new construction, add a layer of foam between window frame and wall.

E. Fill all cracks and spaces around window frames with caulking compound.

IV. Ways to Modify New Home Floor Plans

It is better to evaluate floor plans before the foundation is poured. A greater than 20% glass area to floor area ratio means too much heat loss. Ways to eliminate glass area include:

1. Take out some windows

2. Take out sliding glass door and use a regular door.

3. Substitute different size windows.

4. Specify storm windows or double paned glass instead of single glass.

5. Do not locate windows on east & west sides.

V. Preventing Heat Gain on the East and West by Shading

The long summer months bring much heat from the sun, especially in this area. The sun's rays are stronger or more direct on the east and west sides in the summer. The rays are also at this angle for a longer period of time. Many homes have too many unshaded windows on the east and west. Windows allowing direct solar radiation to enter the home are called "solar glass." A greater than 4% solar glass area to floor area ratio means too much heat radiating into the home. This, or course, results in higher utility bills in the summer because so much more energy is needed to cool the home. Ways to modify solar glass:

1. When building a new home do not locate windows on east and west exposures. By locating windows on the north and south, the sun can help heat the home in winter. Note: southern glass should have about a 2' overhang to block direct summer sun.

2. Add or install a shading device to east and west windows to prevent direct sun from entering the house. Indoor drapes and blinds do not provide enough help. Shade with:

a. deciduous trees
b. awnings
c. solar film
d. solar screen
e. trellis and vines
f. porch with wide overhang
g. high fence
h. shutters that close

3. Mobile home can be situated on a lot so that the long sides face north and south.

BACKGROUND INFORMATION
VENTILATION AND MOISTURE CONTROL

Attic ventilation is a system used to remove heat and moisture from the attic. Example: wind turbines and eave vents. Without ventilation, heat buildup may become excessive.

During the summer the heat of the sun is radiated onto the roof of a house and then conducted into the attic space. If the attic space is not ventilated, the temperature of the entire roof, wood framework, insulation, attic floor and surrounding air can soar as high as 105 to 160 degrees - even when it is cloudy.

During the day this excessive heat build-up places an extra burden on the air conditioner, and also speeds up the deterioration of roof shingles, insulation, wood framing and electrical wiring in the attic space. At night much of this heat remains trapped in the attic and continues to radiate into the conditioned space below.

In the winter months, excess mositure from the outside air and inside the house often condenses into the attic insulation and lumber, and over time can destroy the effectiveness of the insulation and rot out the lumber.

Inside the home, areas such as the kitchen and bathroom often create excessive amounts of heat and moisture during the summer, placing extra burdens on the air conditioning system.

Proper ventilation is one of the single most important features of an energy sensible home, and there are several methods for achieving it.

There are currently avaiable a variety of ventilating systems that can be recommended for use in an energy sensible house. Three of the most popular and proven systems are: 1) soffit vents and wind turbine, 2) continuous soffit vent and continuous ridge vent, and 3) soffit vents and power ventilator. Another type of ventilation is the gable vent.

Testing on these and other systems is being conducted to obtain accurate performance data. Regardless of which ventilating technique is chosen, the object is to provide a regular exchange of air within the attic space. Take care to allow a sufficient area of intake vents in porportion to the attic area being ventilated. An air flow of at least 1½ cubic feet per minute per square foot of attic floor area is needed in this climate. Ventilation equipment should be sized for the requirements of a specific house, and obtained from a reliable manufacturer.

VENTILATE THE KITCHEN AND BATH

Areas inside the house, such as the kitchen and bathroom, often are the source of excessive amounts of heat and humidity during the summer. It is advisable to exhaust this heat and humidity directly to the outside, rather than place an extra burden on the air conditioning system. ("Powder rooms" or partial baths without a tub or shower should use a recirculating fan with an odor filter to avoid piercing the attic space and insulation.)

Exhaust fans used in the kitchen and bathroom should be equipped with positive sealing dampers to reduce air infiltration in both winter and summer when not in use. Use these fans only when excess heat, moisture or odors are being produced. Make sure they exhaust to the outside air, not the attic space.

VENTILATE CRAWL SPACES

Enclosed crawl spaces should be designed with vents to clear out damp air which could wet insulation or rot out wood.

USE VAPOR BARRIERS PROPERLY

The main purpose of a vapor barrier is to help control the flow of moisture that can damage the structure of a house and reduce insulation effectiveness. A vapor barrier is most necessary when installed underneath a concrete slab on grade, or when used to cover the ground in an enclosed crawl space area. Its use in walls and ceilings in this climate is still being evaluated.

Do not under any circumstances cover both surfaces of a wall, a floor or a ceiling with any materials that act as a positive vapor barrier, as this will trap moisture and result in rapid rotting of all wood within the sealed cavity.

GLOSSARY

GLOSSARY

Active solar system - a space or hot water heating system that depends on energy-consuming equipment (pumps, blowers, electric controls, automatic tracking devices, etc,) to collect or to move the solar heat.

Air conditioning - the process of treating air to control its temperature, humidity, cleanliness, and distribution within a particular space.

Air conditioning filter - material usually made of fiberglass or foam rubber used to collect dust, dirt, grease and other particles and to prevent them from entering mechanical heating and cooling equipment.

Air Exchanges - uncontrolled movement of a volume of air in or out of a room or an entire building over a period of time. Air exchanges (AE) are sometimes expressed as whole-volume exchanges per hour or, alternatively, as cubic feet per minute (CFM). A standard, insulated new home is expected to have 1 AE/hour; a specially constructed, energy-efficient house may have only 1/2 AE/hour. Drafty, uninsulated houses typically have 2 - 4 AE/hour.

Air pollution - a level of concentration of foreign materials in the air that unfavorably affects the life and health of air breathing plants and animals (especially humankind) and/or affects property adversely.

Appliance - any device meant for a specific use, but especially those requiring commercial power input for operation. Common household appliances include refrigerators, stoves, toasters, dishwashers, mixers, irons, washers and dryers, television, and stereo sets.

Atomic energy - energy obtained from disturbances within the nucleus of the atom. The resulting disintegration of matter into energy may be spontaneous (as in natural radioactivity) or it may be induced artificially (as in nuclear fission for production of electricity and in uncontrolled fusion for the firepower of hydrogen bombs).

Attic ventilation - system used to remove heat and moisture from the attic. Example: wind turbines and eave vents without ventilation, heat build up may become excessive. At night, heat may continue to radiate into the rooms or space below. Ventilation is also required to remove damaging moisture from the attic.

Types include:

1. Wind turbines
2. Continuous ridge and soffit vents
3. Gables
4. Power vents

Barrel - a liquid volume equal to 42 gallons of 159 liters. One barrel of crude oil has about the same heat energy as 350 pounds of bituminous coal.

Blackout - a shutoff of all electrical power in a given area. It can be caused by storm damage, equipment failure, or overloaded circuits because of unusually heavy consumer use.

Brownout - the deliberate reduction of power to users of electric utilities whenever demand for power exceeds generating capacity. During a brownout, lights will dim and fans run more slowly. Some appliances stop running altogether.

B.T.U. (British Thermal Unit) - the amount of heat energy required to raise the temperature of one pound of water one degree Fahrenheit. One BTU is approximately equal to the amount of heat given off by a wooden match. A pound of coal contains approximately 13,000 BTU of chemical energy.

Calorie - the amount of heat required to raise the temperature of one ml of water one degree Celsius; a metric unit of heat energy.

Capacity - the maximum load for which a generator, transmission circuit, power plant, or system is designed.

Caulking - a soft, semi-solid material that can be squeezed into non-movable joints and cracks of a building, thereby reducing the flow of air in and out of the building.

Coal - solid fuel formed by the decomposition of plants buried deep under Earth's surface. A whole group of naturally occurring, carbon and hydrogen-rich rocks are called "coal". Various types are ranked by the percentage of carbon in dried samples or by the calorie value of moist ones. Age and depth of burial contributed to differential changes in the original plant debris. The concentration of carbon increased over time (hundreds of millions of years) as trapped moisture and gases eventually escaped and pressure forced changes in the organic remainder.

The chemical composition of coal varies widely. It is not homogeneous and regional differences, reflecting both variations in its history of formation and the kinds of plants involved, are common. However, gross distinctions can be made. From least to most carbon-rich, the coal group includes peat, lignite, sub-bituminous and bituminous coals, and anthracite.

Comfort zone - the ranges of indoor temperatures, humidity, and air movement under which most people enjoy a feeling of well-being.

Condensation - the change in state from a gas to a liquid, releasing energy.

Conduction - the flow of heat from a warm material to a cooler one in direct contact with it; the transmission of energy directly from molecule to molecule.

Conservation - making the best use of natural resources by reducing waste, improving efficiency, and slowing the rate of consumption.

Convection - transfer of heat energy by the movement of currents of a liquid or a gas.

Curtailment - cutting back the use of energy resources as opposed to conserving or wisely using resources.

Damper - a device used to vary or stop the volume of air passing through an air inlet, outlet, or duct, such as a fireplace.

Deciduous trees - trees which lose their leaves in the winter. They allow the sun in during the winter but keep the sun out during the summer.

Degree-day - the difference between 65° and the daily temperature. For example, if the low temperature for Friday was 12°F and the high for the day was 28°F, the number of degree-days for the day was

$$(65°F - \frac{28 + 12°F}{2}) = (65°F - 20°F) = 45$$

The greater the number of degree-days in a particular area, the higher the energy consumption for heating and cooling is likely to be.

Ductwork - if your home has central cooling and/or heating, it will have ductwork. Ductwork is the air delivery system to the rooms. It is most commonly found in the attic or in the furred down (low) areas of the ceiling.

E.E.R. (energy efficiency ratio) - rating used to help the consumer determine and compare the operating costs of heating and cooling equipment. E.E.R. indicates how completely an electrical appliance converts energy at the point of use. The rating is derived by comparing heating or cooling power (output) to energy consumed (input). The higher the rating, the more energy-efficient the equipment (Example E.E.R. of 9.0 would cost less to operate than E.E.R. of 6.5).

$$\frac{\text{BTU per hour (cooling capacity)}}{\text{watts (electrical consumption)}}$$

Efficiency - the ratio of useful work or energy output to total work or energy input. One hundred percent energy efficiency is impossible. There is always a cost or "handling charge" in any energy conversion. In addition, some forms of concentrated energy and some energy-consuming systems provide much more energy than is needed to do a particular task. For example, using a 350 horsepower car to transport one healthy person two miles to a swimming pool or gym for exercise is a highly inefficient use of both the driver and the car. A bicycle would be more efficient according to the standard pioneered by the American Physical Society: "thermodynamic efficiency is the ratio of the least available work that could perform the task to the available work actually consumed in doing the job with a given device or system."

Electric meter - device that measures electricity in kilowatt-hours and has either dials or numbers for recording the amount used.

Energy - the ability to produce motion against resistance (work); or, whatever heats, lights, moves, or changes matter.

Energy audit - the examination of a building's construction and materials, mechanical and electrical systems, energy usage patterns, in order to identify possibilities for energy conservation.

Evaporation - the change from liquid to gas which requires extraordinary absorption of heat by the material undergoing this phase change. Liquid water, for example, absorbs 540 extra calories per gram at 100°C as it vaporizes. This heat will be released again if the water vapor condenses.

Evergreen trees - trees that keep foliage all winter. Coniferous trees are evergreens which make especially good windbreaks.

Fiberglass - a material made of extremely fine filaments of glass which are used in masses as insulation.

Flourescent lamp - a lighting device in which light is produced by the passage of electricity through a metallic gas enclosed in a tube. Flourescent bulbs provide about four times as much illumination per watt as incandescent ones do; they give off about 75% less heat; they cost more initially but they last approximately seven times longer than incandescents; and they include types that can be used in existing incandescent fixtures.

Foot candles - the unit of direct illumination at a given location, equivalent to the energy of light received on a surface at a distance of one foot from a standard candle. It is equal to one lumen per square foot.

Forced air - a common type of heating system in which air heated in a furnace is then blower-driven or "forced" through ducts to all areas of the building. The primary fuel may be coal, fuel oil, natural gas, or wood, but electricity is also needed to power the blower and thermostat.

Fossil fuel - any naturally occurring underground fuel formed by decomposition and/or metamorphosis of the remains of ancient life forms. Coal, crude oil, and natural gas are fossil fuels.

Fuel - any substance used to provide heat energy.

Gasket - rubber, plastic, or metal band used around the door frames of appliances and cars to form a tight seal, reducing energy losses by infiltration.

Geothermal energy - heat trapped in the interior of the Earth is called geothermal energy. Boreholes into the crust show an average temperature increase of 1°C for every 30 meters depth, or about 100°F per mile. Geothermal heat is believed to come from the decay of radioactive materials deep in the Earth as well as some from friction of rock movements, tidal forces, and perhaps other sources. This heat keeps great quantities of buried rock molten and hot. Some of this energy escapes at the surface as hot water. Geothermal energy is available in four forms; dry steam, wet steam, hot rocks, and geopressured hot water.

Greenhouse effect - the warming effect of carbon dioxide and water in the atmosphere acting as a "lid" to slow the escape of heat from the Earth's surface. Molecules of water and carbon dioxide absorb and reradiate back to Earth much of the heat radiated from it.

Heat gain - the amount of heat provided to an enclosed space from all sources, including people, lights, appliances, sunshine, and furnace; a figure used to estimate the size and performance of heating and air conditioning system.

Heat loss - a decrease in the amount of heat contained within an enclosed space, resulting from heat flow through walls, windows, roof, and other building components.

Heat pump - a device that transfers heat from a cooler region to a warmer one (or vice versa) by the expenditure of mechanical or electrical energy. The heat pump operates by alternately evaporating and condensing a refrigerant, or heat transferring fluid, in a closed cycle. It differs from a typical refrigeration unit in that the heat pump can reverse its cycle to provide heat instead of removing it. Heat pumps are both heaters and air-conditioners and, compared to electric resistance elements often used in all-electric homes, they are more efficient.

Hydroelectric plant - an electric power plant in which the turbine-generators are driven by falling water.

Incandescent light - a common lighting device containing a solid filament that glows when electric current is passed through it. The filament's resistance to the current makes it glow with heat. The output of an ordinary incandescent bulb is about 95% heat.

Infiltration - the natural process by which air leaks into or out of a building, especially through cracks around doors, windows, vents, electrical outlets, and any other small openings or breaks in the exterior surface. Wind, significant temperature differences between the interior and exterior, lack of caulking and weatherstripping, numerous windows and vents, and inadequate insulation all contribute to high rates of infiltration.

Insulation - material used in home construction to retard (slow down) the heat loss from a home in the winter and heat gain in summer. Some commonly used materials are fiberglass, cellulose, mineral or rock wool, and styrofoam.

Intermediate peak period - 10 a.m. to 2 p.m. and 6 p.m. to 10 p.m. in GSU service area. A period of moderate use of electricity.

KWH - (kilowatt-hour) - the amount of energy equal to 1000 watts of electricity used for one hour. (Example: Ten 100-watt light bulbs burning for one hour.)

Life cycle cost - the total cost of an article over its entire useful life, including operating, maintenance, and financing expenses in addition to the purchase price.

Megawatt - a unit of power equal to 1,000 kilowatts or 1,000,000 watts. It is usually used to describe the capacity of power plants.

Natural gas - mixture of gaseous hydrocarbons occurring naturally in certain rocks. There are several kinds of gas trapped in porous rocks underground. One of these "natural gases" is methane, used as a commercial fuel. Petroleum deposits always include some methane, but natural gas deposits are not always accompanied by petroleum. Natural gas is commonly sold to individuals in hundreds of cubic feet (Ccf), the unit appearing on household utility bills. One Ccf of commercial methane has about 25,000 Calories, the equivalent of 8 pounds of coal of 0.7 gallons of crude oil.

Natural gas meter - device that has dials like the electric meter, but measures gas consumption in hundreds of cubic feet.

Non-renewable resources - energy resources that are not being replaced during human history. Examples are coal, oil, natural gas, and uranium.

Nuclear power plant - a generating station that converts nuclear energy into some form of useful power, such as mechanical or electrical power. In a nuclear power plant, heat produced by a reactor is generally used to make steam to drive a turbine that, in turn, drives an electric generator.

Nuclear reaction - a change in an atomic nucleus due to fission, fusion, neutron capture, or radioactive decay, as distinguished from a chemical reaction which is limited to changes in electron structure surrounding the nucleus.

Off-peak period - when demand for electricity is the least. 10 p.m. to 10 a.m. on weekdays and all weekend in GSU service area. (On weekends, industries do not need as much electricity and businesses are closed.)

Overhang - a solid horizontal projection on the exterior of a building placed (ideally) so that it shades southern windows in summer only. An overhang may be fixed or movable, part of the original construction or a retrofit. Several designs are possible. An upward-tilted overhang can also serve as a reflector in winter.

Passive solar system - Building design, materials, and equipment that together deliver 50 times more heat to the interior of a building than does the non-renewable supplementary energy it uses. Passive systems rely on natural energy flows, collection, and storage with a minimum of mechanical aids and a minimal use of fossil fuels.

Payback period - the amount of time it takes for an energy-saving improvement to pay for itself through savings on the utility bill. If adding R-30 insulation to a home with R-0 insulation costs $500 and you save $250 a year on your utility bill, it would pay for itself in 2 years.

$$\frac{\$500 \text{ (cost for insulation)}}{\$250 \text{ (yearly savings)}}$$

Peak period - Time of day when the greatest demand for electricity occurs (2 - 6 p.m., Monday through Friday).

Petroleum - a naturally occurring, oily, dark-colored liquid mixture of hydrocarbons. Refineries distill this raw material into gasoline, kerosene, diesel fuel, lubricating oil, waxes, and other products.

R-Value - the resistance to heat flow. The higher the R-value, the greater the insulating efficiency of the material. Thickness is a factor also, so R-values are commonly stated per inch of building material. R-values are additive--thicker material or a combination of materials means increased resistance to heat flow. Some typical R-values per inch of material are 6.25 for polyurethane foam; 3.17 for fiberglass batts; 1.25 for fir and pine wood; 0.18 for plaster; and 0.08 for concrete.

Radiation - emission and propagation of energy through space; pure energy that travels rapidly until striking materials that can absorb it. Then absorbed radiation will either induce a chemical change (as in photosynthesis, sun tanning, photography, photovoltaic cells) or increase the random motion of the molecules of the material contributing to its temperature. Examples of bodies emitting radiation are the sun, electric lights, human beings, waters and cements that are warmer than their surroundings, Franklin stoves, and radioactive materials.

Reclamation - Process of replacing the soil, clay, and rocks removed earlier to expose coal or oil shale for strip mining; compacting and leveling the site; and replanting it to restore its appearance and reduce erosion and drainage of waste materials.

Renewable resources - materials that are recycled by natural proccesses within a relatively brief span of time (a human lifetime). Fresh water, wind, sunshine, and trees are some examples of resources that seem to renew themselves within human time frames.

Retrofit - add energy-saving features to an existing home.

Site orientation - the relationship of a home's or building's position to prevailing winds, sun, vegetation, and other buildings, which can affect the heat loss or heat gain performance of the home or building. Example: locating a home so that most of the windows are facing north and south in order to minimize heat gain in the summer.

Solar cell - a thin sheet of semi-metallic material (usually silicon) which can convert energy from the Sun directly into electricity. An individual cell on the retail market in 1980 typically produces a small potential difference of about 0.5 volts and about 0.6 watts of power. An array of solar cells can provide a useful electrical capacity.

Solar collector - a device which collects the Sun's energy as heat. They are made in many shapes and styles: flat-plate, tubular, and concentrating. Air or liquids are the fluid media usually used for heat transfer.

Solar energy - electromagnetic radiation emitted by the nearest star, the Sun. Earth receives about 4.2 quadrillion kilowatt-hours of energy per day from the Sun.

Storm window - a glass or plastic covering for a conventional window, used to provide additional protection from cold and wind. A well-sealed storm window traps an insulating layer of air between itself and the other window, decreasig heat loss due to conduction through the glass and keeping the inside pane warmer.

Strip-mining - a method of mining coal that lies less than 110 feet below the surface. Overburden (soil, clay, and rock, above the fuel) is scraped away by huge mechanical shovels and stored, layer by layer, in separate piles. The coal is removed and then (ideally) layers of overburden are replaced in their former relative positions, topsoil uppermost.

Thermostat - a temperature-sensitive device which turns heating and cooling equipment on and off at set temperatures.

Ton of air conditioning - the thermal refrigeration energy required to melt one ton of ice (2,000 pounds). As a means of expressing cooling capacity, 1 ton = 12,000 BTU/hour cooling.

Vapor barrier - a material used to prevent moisture from passing through warm interior walls of a building and condensing on the cold exterior walls, thus soaking insulation and causing other problems. Plastic sheeting is often sealed against wall studs as a vapor barrier; special backing on batt and blanket insulation, foil or plastic wall coverings and special interior paints are other vapor barriers used to keep humidity inside a building.

Watt - a measure of electrical power. Wattage is a product of the voltage (measure of the "pressure" in an electrical circuit) and the amperes (current or flow of electricity). One volt and one amp applied to a circuit for one hour would use one watt-hour of electricity.

Weather stripping - foam, metal, felt, or rubber strips used to form a seal around windows, doors, vents, and other movable openings where infiltration can occur.

Wind break - a dense row of trees, or a fence or other barrier that interrupts and changes the local path of the wind.